Performance Requirements and Methods of Testing for Electronic Charting Display and Information Systems – Navy (ECDIS-N)

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Enclosure (1)

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FOREWORD

The international maritime community has been addressing the issue of standards for Electronic Chart Display and Information Systems for several years. This culminated in the adoption of International Maritime Organization (IMO) Resolution A.817(19), Performance Standards for Electronic Chart Display and Information Systems (ECDIS) on 23 November 1995. According to that resolution, the primary function of an ECDIS is to contribute to safe navigation. ECDIS, with adequate backup arrangements, may be accepted as complying with up-to-date charts required by regulation V/20 of the Safety of Life at Sea (SOLAS) Convention of 1974, as amended.

U.S. Navy military vessels are exempt from certain aspects of the SOLAS Convention. They generally are not required to comply with IMO resolutions. However, the general requirements for safe navigation apply to all vessels, including military vessels. To set standards in keeping with safe navigation, the Navy will follow Department of Defense (DoD) mandates to use international standards wherever possible.

The CNO letter of 17 Mar 98, "U.S. Navy Electronic Chart Display and Information System Policy", directs the Navy's transition from navigation using paper charts to navigation in an electronic chart environment.   Enclosure (1) to the policy letter establishes the minimum performance standards for ECDIS-Navy (ECDIS-N) which are based on the policy letter reference (c) - IMO Resolution A.817(19). The operational performance requirements, methods of testing and required test results for ECDIS-N are based on the policy letter reference (d) - International Standard IEC 61174. The major differences between an ECDIS and an ECDIS-N are:

Differences Between ECDIS and ECDIS-N

CATEGORY	ECDIS	ECDIS-N
Software Architecture	No requirement	• Joint Technical Architecture (JTA) • Defense Information Infrastructure (DII) Common Operating Environment (COE) compliance
Hydrographic Office	Government Hydrographic Office	National Imagery and Mapping Agency
Database Format	IHO S-57 ENC	NIMA Vector Product Format (VPF): • Digital Nautical Chart (DNC®) • Tactical Ocean Data (TOD) • Littoral Warfare Data (LWD)
Automatic Chart Updating	IHO S-52 Appendix 1	NIMA VPF Database Update (VDU)
Position Systems & Sources	Continuous positioning systems	• Navy standard automated and continuous positioning systems • Navy approved navigation and piloting procedures

This document borrows heavily from the two referenced international standards. Sections from those standards (modified for U. S. Navy requirements) and new sections added for U.S. Navy-specific requirements roughly map to this document as follows:

Section(s)	Source / Follows from
1	A817 - 1
2	A817 - 2, 61174 - 3
3.1 through 3.13	A817 - 3 through 15, 61174 - 4
3.14	A817 – Appendix 6, U.S. Navy additions
3.15	U.S. Navy additions
3.16 through 3.25	61174 - 5.1 through 5.10
4.1 through 4.9	61174 - 6.1 through 6.9
Appendix 1	A817 Appendix 1
Appendix 2..5	A817 Appendix 2 through 5, 61174 Annex A through D

Section(s)	Source / Follows from
Appendix 6, 7	61174 Annex E, F

Notes:

1. A817 means the IMO Resolution A.817(19) of 23 Nov 1995
2. 61174 means International Standard IEC 61174 (Ed. 1) of Sep 1998
3. 61174 section 4 is a re-statement of A817 sections 3 through 15
4. 61174 Annexes A through D are restatements of A817 Appendices 2 through 5

Performance Requirements and Methods of Testing for Electronic Charting Display and Information Systems – Navy (ECDIS-N)

1 INTRODUCTION

1.1 The minimum performance standards for an ECDIS-N were promulgated by the CNO letter of 17 Mar 98 "U. S. Navy Electronic Chart Display and Information System Policy". This document refines and amplifies those performance standards and constitutes the minimum capabilities a candidate ECDIS-N must perform.

1.2 A candidate ECDIS-N seeking certification in accordance with this Instruction shall incorporate the performance standards into the appropriate acquisition documentation (e.g. Mission Needs Statement, Operational Requirements Document, Test and Evaluation Master Plan) and system testing procedures.

1.3 The primary function of the ECDIS-N is to contribute to safe navigation.

1.4 The ECDIS-N should comply to the greatest extent possible with international standards governing navigation.

1.5 The ECDIS-N should meet the general requirements for maritime navigation and radiocommunication equipment and systems contained in IEC Publication 60945.

1.6 The ECDIS-N shall be capable of displaying all chart information necessary for safe and efficient navigation originated by, and distributed on the authority of the National Imagery and Mapping Agency (NIMA).

1.7 The ECDIS-N shall facilitate simple and reliable updating of Vector Product Format (VPF) databases including the Digital Nautical Chart (DNC®) and Tactical Ocean Data (TOD). The updates will be provided by NIMA as defined by the VPF Database Update (VDU).

1.8 Use of ECDIS-N shall reduce the navigational workload as compared to use of a paper chart. It shall enable the operator to execute in a convenient and timely manner all route planning, route monitoring and positioning currently performed on paper charts. It shall be capable of continuously plotting the ship's position.

1.9 The ECDIS-N shall provide appropriate alarms or indications with respect to the information displayed or malfunction of the equipment (see APPENDIX 5).

2 ACRONYMS AND DEFINITIONS[1]

2.1 Acronyms

AIS	Automatic Identification System
ARPA	Automatic Radar Plotting Aid
ATA	Automatic Tracking Aid
DNC®	Digital Nautical Chart
DTDS	DNC® Test Data Set
EBL	Electronic Bearing Line

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[1] Further information on ECDIS definitions can be found in IHO Special Publication S-52, Appendix 3.

ECDIS	Electronic Chart Display and Information System
ECDIS-N	Electronic Chart Display and Information System - Navy
ENC	Electronic Navigational Chart
EPA	Electronic Plotting Aid
EUT	Equipment Under Test
GeoSym	Geospatial Symbols for Digital Displays
IEC	International Electrotechnical Commission
IHO	International Hydrographic Organization
IMO	International Maritime Organization
HO	Hydrographic Office
LWD	Littoral Warfare Data. The standard DoD product controlled by MIL-PRF-89049/7
NIMA	National Imagery and Mapping Agency. The official hydrographic office that provides all charting products to DoD
RCDS	Raster Chart Display System
RNC	Raster Navigational Chart
SDNC	System Digital Nautical Chart
SENC	System Electronic Nautical Chart
SOLAS	Safety Of Life At Sea
TOD	Tactical Ocean Data
VDU	Vector Product Format (VPF) Database Update.
VPF	Vector Product Format
VRM	Variable Range Marker

2.2   Definitions

Alarm	an alarm or alarm system that announces by audible means, or audible and visual means, a condition requiring attention.
Availability (A_O)	calculated as:

$$A_O = \frac{\text{Uptime}}{\text{Uptime} + \text{Downtime}}$$

where uptime is that time when the system is considered to be ready for use and is either operating, in standby, or off. Downtime is the time the system is down for repair of operational mission hardware failures and/or for restoration from operational mission software faults, including off-board logistic delays. It also includes planned maintenance time with a periodicity less than or equal to the test duration time that prevents the system from performing its assigned mission. Planned maintenance time that is of periodicity greater than the test duration time is considered neutral time, and is not included in the availability calculation.

Cached View	a virtual table or index constructed by applying relational algebra (e.g. queries) to the original VPF tables, that contains the data required to

	graphically render the Display Base, the Standard Display, and other displays as defined in the performance standards for ECDIS-N. A cached view must be destroyed and reconstructed, not simply refreshed, whenever the VPF source data is updated (e.g. as the result of applying VDU or changing to a new edition, etc.).
Direct Access	the retrieval of VPF data with reference to its actual location on a storage medium rather than relative to any previously retrieved data.
Direct Read	the method by which an ECDIS-N reads, processes, and displays chart data. The original VPF relational data (tables) are read in the native binary format to maintain the feature and attribute content and to enable the accurate display of and access to all VPF/DNC data.
Display Base	the level of chart data and navigational information that cannot be removed from the display, consisting of information that is required at all times in all geographical areas and all circumstances. It is not intended to be sufficient for safe navigation.
DNC®	a global, vector database standardized as to content, structure, and format, issued for use with ECDIS-N. DNC® is implemented in VPF and conforms to MIL-STD-2407 for its data structure. The data content and coverage are intended to closely replicate NIMA's Harbor, Approach, Coastal, and General chart series and portrays selected significant navigation features in a format suitable for computerized marine navigation and Geographic Information System (GIS) applications. The features depicted are thematically organized into 12 layers or coverages including: Cultural Landmarks, Earth Cover, Environment, Hydrography, Inland Waterways, Land Cover, Limits, Aids to Navigation, Obstructions, Port Facilities, Relief, and Data Quality.
ECDIS	a navigation information system which, with adequate backup arrangements, complies with the up-to-date chart required by regulation V/20 of the 1974 SOLAS Convention. It displays selected information from a SENC with positional information from navigation sensors to assist the operator in route planning and route monitoring, and by displaying additional navigation-related information.
ECDIS-N	a navigation information system which, with adequate backup arrangements, complies with the up-to-date chart required by regulation V/20 of the 1974 SOLAS Convention and Navy Instructions. It displays selected information from a SDNC with positional information from navigation sensors to assist the operator in route planning and route monitoring, and by displaying additional navigational-related information.
ENC	a database, standardized as to content, structure and format, issued for use with ECDIS on the authority of government authorized hydrographic offices. The ENC contains all the chart information necessary for safe navigation, and may contain supplementary information in addition to that contained in the paper chart (e.g. sailing directions) which shall be considered necessary for safe navigation.
GeoSym	symbols and assignment tables needed to support VPF product display systems (MIL-PRF-89045). Feature content is based on the complete feature content of all NIMA VPF product specifications and the graphic symbology specified in IHO S-52, IHO S-57, MIL-STD-2402, SAE ARP5289 and other standard symbology efforts.

Indicator	the visual display giving information about the condition of a system or equipment.
MCMTOMF$_{HW}$	the mean corrective maintenance time for operational mission failures and is the average elapsed corrective maintenance time needed to repair all operational mission hardware failures. It includes time for maintenance preparation, fault location and isolation, on board parts procurement, fault correction, adjustment and calibration, and follow-up checkout time. It does not include off board logistic delay time.

$$MCMTOMF_{HW} = \frac{\text{Total Elapsed Time to Correct Operational Mission Failures}}{\text{Total Number of Operational Mission Failures}}$$

MCMTOMF$_{SW}$	the average elapsed time needed to restore a software-intensive system following an operational mission software fault. This may include the time to restore all processes, functions, files, and databases to a tactically useful state as well as the time required to physically reboot the system following an operational mission software fault.

$$MCMTOMF_{SW} = \frac{\substack{\text{Total Elapsed Time to Restore Software Intensive} \\ \text{Systems After an Operational Mission Software Fault}}}{\text{Total Number of Operational Mission Software Faults}}$$

MTBOMF$_{HW}$	the mean time between operational mission hardware failures occurring during system operation and is calculated as:

$$MTBOMF_{HW} = \frac{\text{Total System Operating Time}}{\text{Number of Operational Mission Hardware Failures}}$$

	where an operational mission failure is a hardware failure that prevents the system from performing its mission. System operating time includes only the time the system is operating and being stressed under operational loads. It does not include standby time.
MTBOMF$_{SW}$	the mean time between operational mission software faults. A software fault is any interruption of system operation not directly attributable to MTBOMF$_{HW}$ and is calculated as:

$$MTBOMF_{SW} = \frac{\text{Total System Operating Time}}{\text{Number of Operational Mission Software Faults}}$$

RNC	Raster Navigational Chart means a facsimile of a paper chart originated by, or distributed on the authority of, a government-authorized hydrographic office. RNC means either a single chart or a collection of charts. The content, structure and format of the RNC are specified in S-61.
SDNC	System Digital Nautical Chart is the database resulting from the direct read of VPF products by the ECDIS-N for appropriate use, updates to DNC® and TOD via VDU, and other data added by the operator. It is the database that is actually accessed by ECDIS-N for the display generation and other navigational functions, and is the equivalent to an up-to-date paper chart. The SDNC may also contain information from other sources.
Ship-centered mode	a display mode in which own ship remains stationary while all charted information moves relative to own ship position.

Standard Display	the level of chart data and navigational information that shall be shown when a chart is first displayed on the ECDIS-N. The level of the information it provides for route planning or route monitoring may be modified by the operator according to the operator's needs. It is intended to be sufficient for safe navigation.
Tactical Ocean Data	data produced by NIMA in VPF under the MIL-PRF-89049 series. TOD contains tactical information such as OPAREA information found on nautical charts, bottom contour charts and bathymetric navigation planning charts.
True-motion mode	a display mode in which own ship moves while the position of all charted information remains fixed.
VDU	VPF Database Update is a method employed by NIMA to meet digital correction and update requirements of VPF data products resident at remote user sites and in operational environments. It may be implemented by replacement of baseline CD-ROMs, download of "replacement libraries", or an automated electronic correction/update method such as "commercial patch".
VPF	Vector Product Format is a standard, structure, and organization for large geographic databases that are based on a geo-relational data model (MIL-STD-2407). VPF allows application software to read data directly without prior conversion to an intermediate form. VPF use tables and indexes that permit direct access by spatial location and thematic content and is designed to be used with any digital geographic data in vector format that can be represented using nodes, edges, and faces.
Wheel-over	a geographic position along the ship's intended track where, taking into account the dynamics of the ship and the prevailing environmental conditions, the operator considers it necessary to put the "wheel-over" to achieve the intended new track.

3   REQUIREMENTS

3.1   DISPLAY OF DNC®and TOD INFORMATION

3.1.1   The ECDIS-N shall be capable of displaying all DNC®and TOD information.

3.1.2   DNC®and TOD information available for display during route planning and route monitoring shall be subdivided into three categories: display base, standard display, and all other information (see APPENDIX 2).

3.1.3   The ECDIS-N shall present the standard display at any time by a single operator action.

3.1.4   When a chart is first displayed subsequent to power up, the ECDIS-N shall provide the standard display at the largest scale available in the SDNC for the displayed area.

3.1.5   It shall be easy to add or remove information from the ECDIS-N display. It shall not be possible to remove from the display information contained in the display base. The addition or deletion of information shall be limited to categories of information (e.g. restricted areas, maritime areas with entry prohibited, soundings, etc.). Adding or deleting an individual item of information (e.g. an individual area or an individual sounding) shall not be permitted (see APPENDIX 2, 2 and 3).

3.1.6   It shall be possible for the operator to select a safety contour from the depth curves provided in the DNC® or TOD. The ECDIS-N shall give the safety contour more emphasis than other depth curves on the display.

3.1.7   It shall be possible for the operator to select a safety depth. The ECDIS-N shall emphasize soundings equal to or less than the safety depth whenever soundings are selected for display.

3.1.8   The DNC® and TOD and all updates to them shall be displayed without any degradation of their information content. Degradation shall be defined as a decrease in information quantity as well as quality with respect to the DTDS provided by NIMA.

3.1.9   The ECDIS-N shall provide a means of ensuring that DNC® and TOD data and all updates to them have been correctly loaded into the SDNC.

3.1.10   The DNC® and TOD data and all updates to them shall be clearly distinguishable from other displayed information, such as, for example, that listed in APPENDIX 3.

3.2   PROVISION AND UPDATING OF CHART INFORMATION

3.2.1   The chart information to be used in ECDIS-N shall be the latest edition of DNC® or TOD originated by NIMA. In order to identify the date and origin of the DNC® and TOD in use, the ECDIS-N shall include an index of DNC® and TOD data available. This index shall be presented upon the operator's request and provide access to the date / edition of each DNC® and TOD library (i.e. library_ed).

3.2.1.1 The ECDIS-N may allow the operator to use the latest edition IHO S-57 format ENC:
- when DNC® data are not available for a specific geographic area; or
- when DNC® data for the area are more than 90 days out of date; or
- when required by joint operations governed by WECDIS[2].

If the ECDIS-N allows the use of ENC data, its operation shall conform to the international standards and specifications for ECDIS defined by IMO A.817, IHO S-52 and IEC 61174.

3.2.1.2 The ECDIS-N may allow the operator to use the latest edition IHO S-61 format RNC when neither DNC® nor ENC data are available for the specific geographic area. If the ECDIS-N allows the use of RNC data, its operation shall conform to the international standards and specifications for ECDIS operating in Raster Chart Display System (RCDS) mode defined by IMO A.817 and IEC 61174.

3.2.2   The contents of the SDNC shall be adequate and up-to-date for the intended voyage, as specified by regulation V/20 of the 1974 SOLAS Convention.

3.2.3   It shall not be possible to alter the contents of the DNC® and TOD.

3.2.4   Updates shall be stored separately from the DNC® and TOD.   However, storage of individual updates may utilize the same data storage area.

3.2.5   The ECDIS-N shall be capable of accepting official updates to the DNC® and TOD data via VDU (see 3.25.1.1). These updates shall be automatically applied to the SDNC. By whatever means updates are received, the implementation procedure shall not interfere with the display in use. A new edition of a DNC® or TOD will supersede any previous edition and all of its integrated updates for that DNC® or TOD.

3.2.6   The ECDIS-N shall also be capable of accepting unofficial, non-integrated updates to the DNC® and TOD data entered manually with simple means for verification prior to the final acceptance of the data updates. They shall be distinguishable on the display from DNC® and TOD information and its official updates, and shall not affect display legibility.

3.2.7   The ECDIS-N shall keep a record of updates for each DNC® and TOD, including time of application to the SDNC, until they are superceded by a new edition.

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[2] "Warship ECDIS". See NATO STANAG 4564.

3.2.8   The ECDIS-N shall allow the operator to display updates so that the operator may review their contents and ascertain that they have been included in the SDNC.

3.3   SCALE

3.3.1   The ECDIS-N shall provide an indication whenever:

.1   the information is displayed at a larger scale than that contained in the DNC® or TOD; or

.2   own ship's position is covered by a DNC® or TOD at a larger scale than that provided by the display.

3.4   DISPLAY OF OTHER NAVIGATIONAL INFORMATION

3.4.1   Radar information and other navigational information, when added to the ECDIS-N display, shall not degrade the SDNC information and shall be clearly distinguishable from the SDNC information.

3.4.2   The ECDIS-N and added navigational information shall use a common reference system. If this is not the case, an indication shall be provided.

3.4.3   When a radar image is added to the ECDIS-N display:

3.4.3.1   Transferred radar information may contain both the radar image and ARPA or ATA or EPA plotting information. Where plotting information is added it shall be indicated whether the vectors are relative or true, and if true whether they are sea or ground stabilized.

3.4.3.2   The chart and the radar image shall match in scale and in orientation. Additionally, the SDNC and radar image shall match in projection.

3.4.3.3   The radar image and the position from the position sensor shall both be adjusted automatically for antenna offset from the conning position.

3.4.3.4   It shall be possible to adjust the displayed position of the ship manually so that the radar image matches the SDNC display. If an offset is applied, it shall be clearly indicated. The details of the offset shall be readily available.

3.4.3.5   It shall be possible to remove the radar information by single operator action.

3.4.4   Line of Position (LOP) Fix

3.4.4.1   The ECDIS-N shall provide the capability to enter bearing and distance LOPs from ownship to charted aids to navigation and conspicuous objects, and to resolve these LOPs into a fix or running fix in the case where LOPs are not obtained from near simultaneous observations. The ECDIS-N shall be able to resolve LOPs entered as either true or relative bearings.

3.4.4.2   The ECDIS-N shall be able to generate and display up to 6 LOPs simultaneously. The ECDIS-N will require a minimum number of LOPs to resolve into a "fix" or an "estimated position" as specified in the Type Commander Navigation Standard for the installed platform.

3.4.4.3   The ECDIS-N shall provide a capability to enter gyrocompass error as required into the system. This error shall be included when resolving LOPs into a fix, running fix or estimated position

3.4.4.4   It shall be possible to display concurrently both the assumed ship's position and the LOPs drawn from objects shot.

3.4.4.5   The ECDIS-N shall provide the capability for the operator to visually compare the following:

a) ship's position derived from a continuous positioning system (e.g. GPS, INS); and

b) an estimated position (EP) which has been continuously updated by applying set and drift values to a dead reckoned position which was projected from an LOP fix

3.4.5   Dead Reckoning

3.4.5.1   The ECDIS-N shall provide the capability to construct and display a dead reckoning plot. The dead reckoning plot computed and displayed by the ECDIS-N shall indicate the ordered course and speed, and shall extend through an operator-specified (minimum of 2) number of dead reckoning intervals.

3.4.5.2   The ECDIS-N shall calculate and display set and drift based on fix-to-fix intervals designated by the operator.

3.5   DISPLAY MODE AND GENERATION OF THE NEIGHBORING AREA

3.5.1   It shall always be possible to display the SDNC in a "north-up" orientation. Other orientations are permitted.

3.5.2   The ECDIS-N shall provide for true-motion mode. Other modes are permitted.

3.5.3   When true-motion mode is in use, reset and generation of the neighboring area shall take place automatically at a distance from the border of the display determined by the operator.

3.5.4   It shall be possible manually to change the chart area and the position of own ship relative to the edge of the display.

3.6   COLORS AND SYMBOLS

3.6.1   Colors and symbols recommended by IHO S-52 Appendix 2 and provided by NIMA GeoSym shall be used to represent DNC$^{®}$ and TOD information.

3.6.2   Colors and symbols other than those mentioned in paragraph 3.6.1 shall be those used to describe the navigational elements and parameters listed in APPENDIX 3. These colors and symbols are detailed in APPENDIX 6. Where colors and patterns are required to display military tactical or operational overlays, the ECDIS-N shall provide sufficient colors and patterns so as not to degrade the DNC$^{®}$ information.

3.6.3   SDNC information, when displayed at the scale specified in the DNC$^{®}$ and TOD, shall use the size of symbols, figures and letters as specified in GeoSym consistent with IHO S-52 Appendix-2, 3.1.5 (see paragraph 4.7.1). The GeoSym to be used shall be version 4 or newer.

3.6.4   ECDIS-N shall allow the operator to select whether own ship is displayed in true scale or as a symbol.

3.7   DISPLAY REQUIREMENTS

3.7.1   The ECDIS-N shall be capable of displaying information for:

   .1   route planning and supplementary navigation tasks
   .2   route monitoring.

3.7.2   The effective size of the chart presentation for route monitoring shall be at least 270 mm by 270 mm.

3.7.3   The display shall be capable of complying with the colors and resolutions recommended in IHO S-52 Appendix-2, 4.1.1 and 4.1.5, and the additional colors required for GeoSym and referred to in MIL-HBK-857, 6.6.

3.7.4   The method of presentation shall ensure that the displayed information is clearly visible to more than one observer in the conditions of light normally experienced on the bridge of the ship by day and by night.

3.8   ROUTE PLANNING MONITORING AND VOYAGE RECORDING

3.8.1   It shall be possible to carry out route planning and route monitoring in a simple and reliable manner. The ECDIS-N shall provide a method for the commanding officer to approve the ship's navigation route plan. When the approved route plan is selected and shown on the ECDIS-N display for use in route monitoring, the ECDIS-N shall present an indication that the route plan has been approved by the commanding officer. If a previously approved route plan is modified, it must be re-approved by the commanding officer.

3.8.2   The ECDIS-N shall be designed following ergonomic principles for user-friendly operation.

3.8.3   The largest scale data available in the DNC® for the area given shall always be used by the ECDIS-N for all alarms or indications of crossing the ship's safety contour and of entering a prohibited area, and for alarms and indications according to APPENDIX 5.

3.8.4   Route planning

3.8.4.1   It shall be possible to carry out route planning including both straight and curved segments.

3.8.4.2   It shall be possible to adjust a planned route by:

    .1   adding waypoints to a route;

    .2   deleting waypoints from a route;

    .3   changing the position of a waypoint;

    .4   changing the order of the waypoints in the route

3.8.4.3   It shall be possible to plan an alternative route in addition to the selected route. The selected route shall be clearly distinguishable from the other routes.

3.8.4.4   An indication is required if the operator plans a route across an own ship's safety contour.

3.8.4.5   An indication is required if the operator plans a route across the boundary of a prohibited area or of a geographical area for which special conditions exist (see APPENDIX 4).

3.8.4.6   It shall be possible for the operator to specify a limit of deviation from the planned route at which activation of an automatic off-track alarm shall occur.

3.8.4.7   The ECDIS-N shall provide a method for the operator to highlight navigation objects that will be used to develop visual and radar positions from LOPs.

3.8.4.8   The ECDIS-N shall provide a method for the operator to add at least 3 different overlays that can be used to show distance from nearest land.

3.8.5   Route Monitoring

3.8.5.1   For route monitoring the selected route and own ship's position shall appear whenever the display covers that area.

3.8.5.2   It shall be possible to display a sea area that does not have the ship on the display (e.g., for look ahead, route planning), while route monitoring. If this is done on the display used for the route monitoring, the automatic route monitoring functions (e.g., updating ship's position, and providing alarms and indications) shall be continuous. It shall be possible to return to the route monitoring display covering own ship's position immediately by a single operator action.

3.8.5.3   The ECDIS-N shall give an alarm if the ship, within a specified time set by the operator, is going to cross the safety contour.

3.8.5.4   The ECDIS-N shall give an alarm or indication, as selected by the operator, if the ship, within a specified time set by the operator, is going to cross the boundary of a prohibited area or of a geographical area for which special conditions exist (see APPENDIX 4).

3.8.5.5   An alarm shall be given when the limit for deviation from the planned route specified in 3.8.4.6 is exceeded.

3.8.5.6 The ship's position shall be derived from a continuous system with accuracy consistent with the requirements of safe navigation. A second independent positioning method of a different type shall be provided. The ECDIS-N shall:

.1 be capable of identifying discrepancies between the methods

.2 provide a means for the operator to select the source he wants to use

.3 identify which source is being used

3.8.5.7 The ECDIS-N shall provide an alarm when the input from the position-fixing system is lost. The ECDIS-N should also repeat, but only as an indication, any alarm or indication passed to it from a position-fixing system.

3.8.5.8 An alarm shall be given by the ECDIS-N if the ship, within a specified time or distance set by the operator, is going to reach a critical point on the planned route. The ECDIS-N shall permit the operator to define critical points and the time or distance at which an alarm shall be given. The words "to reach a critical point" shall be considered passing abeam of the critical point on the planned route.

3.8.5.9 DNC® and TOD are referenced to WGS-84. The positioning system and the SDNC shall be referenced to WGS-84. The use of other geodetic datums is not permitted.

3.8.5.10 It shall be possible to display an alternative route in addition to the selected route. The selected route shall be clearly distinguishable from the other routes. During the voyage, it shall be possible for the operator to modify the selected sailing route or change to an alternative route.

3.8.5.11 It shall be possible to display:

.1 time-labels along ship's track, manually on demand and automatically at intervals selected between 1 and 120 m; and

.2 an adequate number of points, free movable electronic bearing lines (EBL), variable (VRM) and fixed-range markers and other symbols required for navigation purposes and specified in APPENDIX 3. These colors and symbols are detailed in APPENDIX 6. An "adequate number" of EBLs and VRMs implies at least one of each.

3.8.5.12 It shall be possible to enter the geographical co-ordinates of any position and then display that position on demand. It shall also be possible to select any point (features, symbol or position) on the display and to read its geographical co-ordinates on demand.

3.8.5.13 It shall be possible to adjust the ship's geographical position manually. These manual adjustments shall only apply to the source selected at the time the offset was determined, shall be noted alpha-numerically on the screen, maintained until altered by the operator, and automatically recorded.

3.8.6 Voyage recording

3.8.6.1 The ECDIS-N shall store and be able to reproduce certain minimum elements required to reconstruct the navigation and verify the official database used during the previous 12 hours. To ensure a record of own ship's past track and of official data used, the following data shall be recorded:

.1 time, position, heading, and speed (one-minute intervals)

.2 [submarines only] depth (one-minute intervals)

.3 DNC® and TOD source, edition, date, library and update history (initially and for each change).

3.8.6.2 The ECDIS-N should have the capability to record time, position and depth from the sounder for download to removable media.

3.8.6.3 The ECDIS-N shall record the complete track for the entire voyage, with time marks at intervals not exceeding 4 hours.

3.8.6.4 It shall not be possible to manipulate or change the recorded information.

3.8.6.5   The ECDIS-N shall have the capability to preserve the record of the previous 12 hours and of the voyage track.

3.9   ACCURACY

3.9.1   The accuracy of all calculations performed by the ECDIS-N shall be independent of the characteristic of the output device and shall be consistent with the SDNC accuracy. The output device includes the ECDIS-N display, stored memory, and/or printout.

3.9.2   Bearing and distance drawn on the display, or those measured between features already drawn on the display, shall have an accuracy consistent with that afforded by the resolution of the display but no more than that afforded by the scale of the SDNC.

3.10   CONNECTION WITH OTHER EQUIPMENT

3.10.1   The ECDIS-N shall not degrade the performance of any equipment providing sensor inputs. Nor shall the connection of optional equipment degrade the performance of ECDIS-N below these standards.

3.10.2   [The requirements of this section are superceded by those in section 3.14.1, 3.14.2, and 3.14.3].

3.11   PERFORMANCE TESTS, MALFUNCTION ALARMS AND INDICATIONS

3.11.1   The ECDIS-N shall be provided with means for carrying out shipboard diagnostic tests of major functions either automatically or manually. Tests of major functions shall include the integrity of sensor input. If there is any detectable reason why the information presented to the operator is invalid, adequate and clear warnings shall be given to the operator. In case of a failure, the test shall display information to indicate which lowest replaceable unit (LRU) is at fault. These tests / diagnostics should be characterized by the following parameters:

Probability of correct detection (P_{cd}) shall be $\geq 90\%$
Probability of correct fault isolation (P_{cfi}) shall be $\geq 85\%$
Probability of false alarm (P_{fa}) shall be $\leq 5\%$

3.11.2   The ECDIS-N shall provide a suitable alarm or indication of system malfunction.

3.12   BACKUP ARRANGEMENTS

3.12.1   Adequate backup arrangements shall be provided to ensure safe navigation in case of an ECDIS-N failure. It shall be possible to transfer to the backup system within 3 minutes of a critical navigation situation. Facilities enabling a safe take-over of the ECDIS-N functions shall be provided to ensure that an ECDIS-N failure does not result in a critical situation.

3.12.2   A backup arrangement shall be provided facilitating means for safe navigation of the remaining part of the voyage in case of an ECDIS-N failure.

3.12.3   Presentation of chart information: The backup system shall display in graphical (chart) form the relevant information of the hydrographic and geographic environment which are necessary for safe navigation.

3.12.4   Route planning: The backup system shall be capable of performing the route planning functions, including:

   .1   taking over of the route plan originally performed on the ECDIS-N;
   .2   adjusting a planned route manually or by transfer from a route-planning device.

3.12.5 Route monitoring: The backup system shall enable a take-over of the route monitoring originally performed by the ECDIS-N, and provide at least the following functions:

.1 plotting own ship's position automatically or manually on a chart;

.2 taking courses, distances and bearings from the chart;

.3 displaying the planned route;

.4 displaying time labels along ship's track;

.5 plotting an operator defined number of points, bearing lines, range markers, etc., on the chart.

3.12.6 Display information: If the back up is an electronic device, it shall be capable of displaying at least the information equivalent to the Standard Display as defined in these operational and performance requirements.

3.12.7 Provision of chart information:

.1 The chart information to be used shall be the latest editions of that originated by a government hydrographic office, and based on NIMA or IHO standards. NIMA produced and distributed products shall be used before other HO products are used (see paragraph 3.2.1).

.2 It shall not be possible to alter the contents of the chart information.

.3 The chart or chart data edition and issuing date shall be indicated.

3.12.8 Updating: The information displayed by the ECDIS-N backup arrangements shall be up-to-date for the entire voyage.

3.12.9 Scale: If an electronic device is used, it shall provide an indication:

.1 if the information is displayed at a larger scale than that contained in the database; and

.2 if own ship's position is covered by a chart at a larger scale than that provided by the system

3.12.10 If radar and other navigational information are added to an electronic backup display, all the corresponding requirements of these operational and performance requirements shall be met.

3.12.11 If an electronic device is used, the display mode and generation of the neighboring area shall be in accordance with paragraph 3.5 of these operational and performance requirements.

3.12.12 Voyage recording: The backup arrangements shall be able to keep a record of the ship's actual track, including positions and corresponding times.

3.12.13 Malfunctions, warnings, alarms, and indications: If an electronic device is used, it shall provide a suitable indication of system malfunction.

3.12.14 Ergonomics: If an electronic device is used, it shall be designed in accordance with the ergonomic principles of ECDIS-N.

3.12.15 Presentation of Information: If an electronic device is used:

.1 colors and symbols used in the backup arrangements shall be based on IHO S-52 Appendix-2 as implemented by GeoSym.

.2 the effective size of the chart presentation shall be in accordance with paragraph 3.7.2.

3.12.16 Accuracy: Accuracy shall be in accordance with paragraph 3.9.

3.12.17 Connections With Other Equipment: If an electronic device is used, it shall:

.1 be connected to systems providing continuous position-fixing capability; and

.2 not degrade the performance of any equipment providing sensor input.

3.13 POWER SUPPLY

3.13.1 It shall be possible to operate the ECDIS-N and all equipment necessary for its normal functioning when supplied by an emergency source of electrical power in accordance with the appropriate requirements of chapter II-1 of the 1974 SOLAS Convention.

3.13.2 The ECDIS-N shall be able to maintain full operation at one console upon loss of ship's electrical power for a minimum period of 30 minutes.

3.13.3 If an electronic device is used as the ECDIS-N backup, its power supply shall be separate from the power supply of the primary ECDIS-N.

3.14 OPERATIONAL ISSUES

3.14.1 The ECDIS-N, displaying charting information drawn from VPF databases provided by NIMA and updated using VDU procedures, shall be a functional replacement for an up-to-date paper chart on U. S. Naval vessels. The ECDIS-N shall accept and display input from a U. S. Navy approved continuous positioning system. If available on the platform, the ECDIS-N shall accept input from a continuous source of heading data and from a second Navy approved continuous positioning system. The ECDIS-N shall display the platform's present course over ground (COG) and speed over ground (SOG). COG/SOG shall be based on data reported by or derived from U. S. Navy approved navigation sensors. In the event of a failure to the automatic data entry mechanism(s) the ECDIS-N shall accept manual input of position and heading data.

3.14.2 The ECDIS-N shall accept (either automatically or manually) and display data inputs of:

> **.1** Visual position information
> **.2** Radar position information

3.14.3 The ECDIS-N should accept and display all other navigation sensor and data inputs normally available on the vessel on which the system is installed. Examples include:

> **.1** Speed data
> **.2** Manual position information derived from alternate sources or methods (e.g. celestial, bottom contour, etc.)
> **.3** Automatic and/or manual inputs for depth of water beneath the keel, relative wind speed and direction.

3.14.4 The ECDIS-N shall provide a plot of the ship's position within one second of receiving an input from an automated or continuous positioning system and within 10 seconds of receiving an input from any other type of navigation sensor data.

3.14.5 The ECDIS-N shall provide a continuous plot of the ship's position. The ECDIS-N shall plot a symbol to represent the ship's movement and position (see APPENDIX 6). The ECDIS-N shall compute and display set and drift.

3.14.6 [Surface ships only] The ECDIS-N shall provide for a "magnetic heading mode of operation". In this mode, the ECDIS-N shall automatically apply any required correction for magnetic variation and deviation to manually entered heading inputs. The correction for magnetic variation shall use a value supplied by NIMA (either from the DNC® or from the World Magnetic Model). Corrections for magnetic deviation shall use a lookup table that is specific to the source from which the reading was taken.

3.14.7 The primary ECDIS-N[3] shall meet the following minimum maintainability and reliability requirements:

$$MTBOMF_{SW} \geq 100 \text{ hours}$$

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[3] The ECDIS-N excluding the backup.

$$\text{MTBOMF}_{HW} \geq 200 \text{ hours}$$
$$\text{MCMTOMF}_{SW} \leq 30 \text{ minutes}$$
$$\text{MCMTOMF}_{HW} \leq 2 \text{ hours}$$

3.14.8 The backup arrangements shall provide reliable operation under prevailing environmental and normal operating conditions. In order to ensure that safe navigation is not compromised in the event of an ECDIS-N failure, the following configurations are acceptable means of achieving this level of availability. A_O accounts for preventative maintenance (e.g. daily reboot).

    .1   dual redundant ECDIS-N (primary and backup fully integrated) with a composite availability of:

$$A_O \text{ (dual redundant)} \geq .99925$$

There may or may not be distinct "primary" and "backup" modes, but during all "up-time" the system complies with all ECDIS-N requirements.

    .2   a primary ECDIS-N with a separate backup ECDIS-N, where the independent ECDIS-Ns have the availability of:

$A_O \text{ (primary)} \geq .985$ (full functionality)

$A_O \text{ (backup)} \geq .95$ (functionality may be limited to that specified in paragraph 3.12)

    .3   a primary ECDIS-N with a NIMA paper chart to provide backup capability, where:

$A_O \text{ (primary)} \geq .985$ (full functionality)

    .4   a primary ECDIS-N with the capability to print color charts at an acceptable size and scale.

$A_O \text{ (primary)} \geq .985$ (full functionality)

Note – this presumes that policies are implemented to ensure that required paper backup charts are printed prior to a voyage.

3.14.9 Operational Security: The ECDIS-N and its backup arrangements shall provide the capability to display, process and store classified data commensurate with the mission security requirements of the host ship.

3.14.10 Compatibility: The ECDIS-N and its backup arrangements shall have no deleterious effect on the operation of other ship's systems; nor shall the electromagnetic, electrical, human, functional or physical environment of the ship adversely effect the ECDIS-N or its backup arrangements. The ECDIS-N and its backup arrangements shall be compatible with all aspects of the host platforms operational environment including the electromagnetic environment. Electromagnetic environmental effects shall not degrade the operational and performance requirements of the ECDIS-N or its backup arrangements.

3.14.11 Interoperability:

3.14.11.1   The ECDIS-N shall achieve some degree of interoperability and system configuration standardization by complying to level 5 of the Defense Information Infrastructure Common Operating Environment (DII COE). The specific requirements of level 5 compliance shall be defined by the checklist in the DII COE Integrated & Run-Time Specification, version 4.0, Appendix B-5. Clarification / waivers to the compliance checklist are:

    .1   The requirement for GUI compliance is waived.

    .2   For the purpose of DII-COE compliance, the ECDIS-N and its SDNC are not considered to be an RDBMS.

3.14.11.2   The ECDIS-N shall be compliant with the DoD Joint Technical Architecture (JTA) version 3.0.

3.14.12 Components of the ECDIS-N and its backup arrangements may be susceptible to computer network attack / exploitation (CNA/CNE). Information on these threats is provided in the current

Office of Naval Intelligence threat assessment and shall be referenced in the appropriate acquisition documentation for the program providing the ECDIS-N capability.

3.14.13 Safety: The ECDIS-N and its backup arrangements shall present no safety hazards to ship's personnel.

3.15   REQUIRED SUPPORT

3.15.1   Integrated Logistics Support (ILS): An ILS system shall be established for the ECDIS-N and its backup arrangements in order to fully support fleet maintenance. This ILS system shall include operator and maintenance technical manuals, planned maintenance system documentation, maintenance requirements cards, allowance parts lists, and a detailed drawings package.

3.15.2   Training shall be provided at the time of installation to ships force personnel. Training modules to support the operation and maintenance of the ECDIS-N and its backup arrangements shall be incorporated into the Navy training pipeline for applicable officers and enlisted personnel.

3.16   CONTENT AND STRUCTURE OF CHART DATA

3.16.1   The ECDIS-N shall be capable of performing a Direct Read of the DNC® and TOD for incorporation into the SDNC. Such data include both that contained in the original DNC® and TOD and that delivered in digital format to update the SDNC® via VDU.

3.16.2   The precision of HO supplied data shall be maintained, e.g. HO data provided in degrees and decimal degrees, when incorporated in the SDNC and used in calculations, shall also be maintained to that accuracy.

3.17   PRIORITY OF CHART DISPLAY

Layers are required to establish the priority of data on the display. The general rule for the priority between different categories of information is given below[4] :

   .1   ECDIS-N visual alarms/indications (e.g. caution, overscale)

   .2   DNC® and TOD data: points/lines and areas plus official updates

   .3   Notices to mariners, manual input and radio navigational warnings

   .4   DNC® caution

   .5   DNC® and TOD color-fill area data

   .6   DNC® and TOD on demand data

   .7   Radar information[5]

   .8   Operator's data: points/lines and areas[6]

   .9   Manufacturer's data: points/lines and areas

   .10   Operator's color-fill area data

3.18   DISPLAY OF CHART INFORMATION

3.18.1   Scale and Navigation Purpose

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[4] This list is not intended to indicate a drawing sequence, but to specify that the information content of category n+1 must not obscure the information content of category n or any higher category (i.e. n-1, etc.).
[5] Radar information shall have an off-switch to facilitate its removal (see paragraph 4.8.13). In order to meet the requirements of paragraph 3.4.3.4 to adjust ship's position, the ECDIS-N may incorporate the capability of changing the radar priority of the presentation library. Operation of this feature shall be clearly indicated.
[6] In order to meet the requirements of paragraph 3.4.4 to resolve LOPs into a fix or running fix, the ECDIS-N may chang the priority of operator-entered points and lines.

3.18.1.1 If data from different compilation scales appears on the display, the boundary between different scales shall be clearly indicated as specified in IHO S-52 Appendix 2, 3.2.3 (8a) and Annex-A, 12.2.2[7].

3.18.1.2 When the display cannot be completely covered with DNC® or TOD data for the selected navigational purpose, the remaining part of the display shall be filled with DNC® or TOD data based on a more general navigational purpose, if available. When the display cannot be completely covered with DNC® or TOD data, the remaining part of the display may be filled with ENC or RNC data (see paragraph 3.2.1). NIMA products shall be used before other HO products are used.

3.18.1.3 A graphical index of the navigational purpose of available chart data shall be shown on demand.

3.18.1.4 Data shown on the display shall always be of the same display scale. If a compilation scale boundary is shown on the display, the information shown in the overscale area shall not be relied upon at the scale of the display. The overscale area shall be identified as specified in IHO S-52 Appendix-2, 3.2.3 (8b) and Annex-A, 12.2.2[7]. This overscale identification only applies to automatic area scaling of parts of the display; it does not apply to overscaling of the entire display commanded by the operator.

3.18.1.5 The ECDIS-N shall give the operator the ability to use intermediate display scales, or zoom in between scales.

3.18.1.6 A scale bar shall be provided as part of the display base for navigating on a large compilation scale (1:80,000 and larger). The scale bar is specified in IHO S-52 Appendix-2, 3.2.3 (9)(a).

3.18.1.7 For chart displays at a display scale smaller than 1:80,000, a latitude bar shall be shown on the border of the standard display. The latitude bar is specified in IHO S-52 Appendix-2, 3.2.3 (9)(b).

3.18.2 The text on the ECDIS-N shall be readable from 1 meter. Sans serif, non-italic fonts shall be employed. The computer "Ø" shall not be used.

3.18.3 Units and Legend.

3.18.3.1 The ECDIS-N shall allow the operator to select a consistent set of units for display of depth, height, and distance. The following sets of units shall be available on an ECDIS-N display. Sets of units shall not be intermixed. The ECDIS-N power-on default shall be SET 1 (metric).

SET 1 (METRIC)
Depth	meters
Height	meters
Distance	meters or kilometers or nautical miles

SET 2 (ENGLISH)
Depth	feet or (fathoms & feet) – values shall be derived by scaling the metric values in the SDNC and then truncating to shallower depths.
Height	feet
Distance	yards or kyards or nautical miles

The system shall also support:
Position	latitude and longitude in degrees, minutes & decimal minutes
Speed	knots
Time	hours, minutes and seconds
Direction	degrees

3.18.3.2 The display of fractions (i.e. numerator over denominator) for soundings is not allowed. Soundings displayed with coarse and fine resolution components shall be composed of a

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[7] IHO ECDIS Presentation Library conditional symbology procedure "DATCRV01".

whole / integer part (meters or fathoms) with a subscript of decimal meters or feet respectively.

3.18.3.3 Units used shall be indicated in the display legend. There shall be no ambiguity about the units in use at a particular time.

3.18.3.4 A standard legend of general information relating to the area displayed, applicable to the ships position, shall be shown on a graphic or text display. This legend shall contain as a minimum:

> .1 units for depth
> .2 units for height
> .3 scale of display
> .4 data quality indicator
> .5 sounding/vertical datum
> .6 horizontal datum (WGS-84)
> .7 the value of the safety depth if used
> .8 the value of the safety contour if used
> .9 magnetic variation
> .10 date and number of last update affecting the DNC® and TOD libraries currently in use
> .11 edition number and date of issue of the DNC® and TOD
> .12 chart projection

3.19   DISPLAY FUNCTIONS

3.19.1   DNC® and TOD Feature information

3.19.1.1 It shall be possible to call up all the information associated with a DNC® or TOD feature by cursor inquiry on its symbol. This shall extend to areas (e.g. restricted areas, depth areas, etc.), to "no symbol" areas (e.g. territorial seas, etc.) and to meta areas (e.g. information about the areas such as compilation scale, etc.). The search for area information may be limited to the tile boundaries enclosing the cursor but shall not extend beyond the library boundaries enclosing the cursor, but may be limited to the tile boundaries enclosing the cursor.

3.19.1.2 By identifying any feature (point, line or area) with a cursor on the ECDIS-N display, the feature description and all available attributes shall be displayed in text in common language terms.

3.19.1.3 Text shall not appear automatically whenever the feature it is associated with appears on the display. It shall always be possible to remove text independently of the feature.

3.19.2   Navigational Information: If the ECDIS-N offers a ship-centered display mode, the ECDIS-N shall avoid overwriting between the ship symbol and a "centered" symbol for an area that wholly encloses the display (e.g. the traffic direction arrow in a very large traffic lane such as Dover Strait). This can be accomplished by moving the "centered" symbol. When the "centered" symbol is visible beneath the ship symbol, movement is not required.

3.19.3   Safety Contour

3.19.3.1 If the operator does not specify a safety contour, the safety contour shall default to the 30 m depth curve. If the safety contour specified by the operator is not contained in the DNC® or TOD, the safety contour shown shall default to the next deeper depth curve.

3.19.3.2 If the safety contour in use becomes unavailable due to a change in source data, the safety contour shall default to the next deeper depth curve. In each of the above cases, the operator shall be informed.

3.19.3.3 At all times, the safety contour shown shall be the depth curve specified by the operator or the next deeper depth curve if the specified one is not available.

3.19.4   Navigational Calculations

3.19.4.1 The system shall be capable of performing at least the following calculations:

  .1 geographical co-ordinates to display co-ordinates and vice versa
  .2 true distance and azimuth between two geographical positions
  .3 geographic position from known position and distance/azimuth
  .4 rhumb line
  .5 great circle

3.19.4.2 The accuracy of these calculations shall be such that there shall be no visible distortion on the display between the following:

  .1 rhumb line and chart data
  .2 great circle and chart data

3.20 SUPPLEMENTARY DISPLAY FUNCTIONS

3.20.1 Additional Operator's Information: The operator shall be provided with the capability of adding at least the following symbols, lines and areas to the SDNC, and shall be able to revise or delete them:

  .1 the caution (!) or information (i) symbol used to call up a note on the text display by cursor picking
  .2 simple lines and areas with or without color fill, set up for cursor picking to give explanatory note in the text display
  .3 any of the symbols in GeoSym
  .4 text notes

3.20.2 Additional Non-HO Information

3.20.2.1 Additional information from non-HO sources may be displayed providing this does not degrade the display of DNC®, TOD, ENC or RNC data. This additional information shall be distinguished from the HO data.

3.20.2.2 If the area covered by the ECDIS-N display includes waters for which no DNC®, TOD, ENC or RNC at a scale appropriate for navigation exists, the areas representing those waters shall carry an indication to the operator that the electronic charting data is inadequate for safe navigation.

3.20.2.3 An area with no chart data of any kind shall be marked with the "no data" symbology defined in IHO S-52 Appendix-2, 3.2.3 (14).

3.20.2.4 If an area with no DNC®, TOD, ENC or RNC data is covered by non-HO data, the area shall be marked by the "non-HO area" symbology defined in IHO S-52 Appendix-2, 3.2.3 (13b).

3.20.2.5 Should an "unknown object" occur in the DNC® or TOD which is not adequately defined or for which no symbol exists, its presence shall be indicated on the display by a magenta "?" with the IMO category of "Standard Display".

3.20.3 Tidal Adjustment: Depth information shall only be displayed as it has been provided in the DNC® or TOD and not adjusted by tidal height.

3.21 USE OF COLORS AND SYMBOLS

3.21.1 It shall be possible to display the GeoSym version number.

3.21.2 The ECDIS-N shall provide an "ECDIS-N Chart 1" showing both simplified and full chart symbols and their explanations. The ECDIS-N shall provide linking by cursor interrogation between the symbols and the explanations. This may be limited to those symbols contained in GeoSym that correspond to symbols contained in the "ECDIS Chart 1" included in the IHO ECDIS Presentation Library. ECDIS Chart 1 may be used to accomplish this requirement.

3.21.3 The ECDIS-N shall provide color differentiation test diagrams to enable the operator to detect the stage at which the display can no longer be used to discriminate important features by color. There shall be one diagram for each color table. The ECDIS-N shall allow selection and display of these test diagrams. The diagrams shall be used to check color discrimination within all of the tables except Day-Bright. The color differentiation test diagrams contained in the IHO ECDIS Presentation Library and coded in IHO S-57 format may be used to accomplish this.

3.22 DISPLAY CHARACTERISTICS

3.22.1 Information shall be displayed in the ECDIS-N on one or more physical screens, which may be divided into more than one display. Information may be displayed automatically, on demand, or as a result of hand-entry. The following rules apply:

3.22.1.1 The units for depth shall always be on the same screen as the chart display.

3.22.1.2 The following information shall be visual on demand on the same screen as the chart display is visual or on an additional graphic or text display:

    .1 positional data and time
    .2 legend
    .3 feature description and associated attributes (result of "cursor query")
    .4 textual information from DNC® and TOD
    .5 list of abbreviations from "International Chart 1" (INT-1)
    .6 result from navigational computations
    .7 record of DNC® and TOD updates
    .8 list of categories which are removed from Standard Display
    .9 symbol library

3.22.1.3 Navigators' notes shall be visual as a result of a hand-entry on the same screen as the chart display or on an additional graphic or text display.

3.22.2 If more than one display station is provided for the ECDIS-N, the displays shall be coordinated such that changes to data at one display shall be utilized at all displays in the system within 10 seconds. For example, a change to a route at one station will cause the route display to be updated at all stations.

3.23 PERFORMANCE REQUIREMENTS

3.23.1 Redraw

3.23.1.1 The ECDIS-N shall take less than 5 seconds to redraw the chart display during route monitoring to follow the ship's progress, including scale changes due to change in the scale of the chart information. Demands by the operator that cannot be predicted by the ECDIS-N, such as drawing at a different scale or in a different area may take more than 5 seconds. In the latter case:

    .1 the operator shall be informed
    .2 the display shall continue route monitoring until the new information is ready to draw within 5 seconds

3.23.1.2 If there is a delay in preparing (re-generating) data for display (e.g. due to a request for scale change or look ahead to another area) the ECDIS-N shall inform the operator. The previous display shall be maintained and updated, until the new display is ready for re-draw.

3.23.2 Resolution

3.23.2.1 The ECDIS-N shall provide a display meeting the minimum lines per mm (L) given by $L = 864/s$, where s is the smaller dimension of the chart display area (e.g. for the minimum chart area, s = 270 mm and the resolution is L = 3.20 lines per mm, giving a "picture unit" size of 0.312 mm).

3.23.2.2 The minimum sizes for all symbols shall be as specified by IHO S-52 Appendix-2, 3.1.5 and implemented in GeoSym.

3.23.2.3 The symbols shall always be drawn with at least the same number of pixels as are required to draw the symbol at the size defined in IHO S-52 Appendix-2, 3.1.5 and implemented by GeoSym for the minimum resolution and minimum chart display area (270 mm x 270 mm).

3.23.3 Number of Colors: The ECDIS-N shall use all five palettes generated from the color tables in IHO S-52 Appendix-2, 4.1.1 and 4.1.5, and from the 25 additional colors described in MIL-HDBK-857, 6.6.

3.23.4 Brightness and Contrast

3.23.4.1 The brightness and contrast controls shall have a provision to permit returning to the calibrated setting. The ECDIS-N manual shall carry a warning that use of the brightness control may inhibit visibility of information at night.

3.23.4.2 Five color tables are specified in IHO S-52 Appendix-2, 4.1.1 and 4.1.5. The ECDIS-N shall provide a separate palette generated from each of these tables. The 25 additional colors for GeoSym, described in MIL-HDBK-857, 6.6, shall be available in each color palette.

3.23.4.3 For the "Bright Sun" color table, restricted to color pairs of tabular ΔE[8] (color tolerance) greater than 20:

   .1   The discrimination difference between any two colors displayed shall be not less than 10 ΔE units

   .2   The difference between the color displayed and the CIE color[8] defined in the specification shall be not greater than 16 ΔC[8] (color threshold) units. If a monitor is independently tested, then the differences shall not be greater than 8 ΔC units.

   .3   The luminance of the color displayed shall be within 20% of its specified value. (See paragraph 4.7.3.)

3.23.4.4 If an optical filter is used with color table Night-Filtered, it shall be removable, and of the value 0.9 ND[8] (neutral density).

3.24 ERGONOMIC REQUIREMENTS

3.24.1 The ECDIS-N shall provide the operator with the option of using either the traditional paper chart symbols or the new simplified symbols contained in GeoSym and described in IHO S-52 Appendix-2, 3.2.1(2) as best fits his purpose.

3.24.2 If the display orientation is not north, the north arrow shall be shown at the top left corner of the chart display, just clear of the scale bar or the latitude scale. The north arrow is specified in IHO S-52 Appendix-2, 3.2.3 (10).

3.24.3 Any windows containing text, diagrams, etc. superimposed on the route monitoring display shall be temporary. "Temporary " for this application means that the window can be moved or removed from the display.

3.24.3.1 It shall be possible to re-locate temporary windows to a less important part of the display, such as on land, or behind the own ship symbol.

3.24.4 An operator's information panel on the same screen as the route monitoring display shall use the user interface colors specified in the tables contained in IHO S-52 Appendix-2, 4.1.1 and 4.1.5 or clearly visible colors which do not detract from the chart display in any of the five mandatory color palettes. The user interface colors specified in the tables contained in IHO S-52 Appendix-2, 4.1.1 and 4.1.5 may be used to accomplish this.

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[8] The terms CIE color, ΔE, ΔC and ND are defined in IHO S-52 Appendix-2

3.25 UPDATE OF CHART INFORMATION

3.25.1 Official Updates

3.25.1.1 It shall be possible to carry out official "updating operations" on the SDNC. There shall be two types of official updating operations:

.1 Total replacement of the DNC® or TOD data with a new edition of DNC® or TOD data received from NIMA. This new data shall be referred to as "base data". The base data version shall be identified by a base_data_ed, a 4-digit string of "wwyy", where ww is the 2-digit week and yy is the last 2 digits of the year. Base data replacement may require a system shutdown. This replacement must be recorded (perhaps manually) in the log file.

.2 A fully automated method using VDU. VDU may be a "library replacement" method, a "patch" method, or some other implementation. It may contain all current changes from the edition date of the base-data, or may rely on the sequential application of previously issued updates. The resultant SDNC shall be identified by a library_ed (also a "wwyy" string) in addition to the base_data_ed. It shall be possible to apply the VDU while in route planning mode without requiring a system shutdown.

3.25.1.2 The ECDIS-N shall be capable of receiving updates by CD-ROM and through an electronic network.

3.25.1.3 The identification of the issuing authority of the update shall be checked to ensure that the update is issued by NIMA.

.1 If any errors are detected from the receiving device, the reception procedure shall be terminated and the DNC® or TOD update flagged invalid in the record of updates. The operator shall be informed of the corruption.

.2 The ECDIS-N shall employ the error detection scheme defined by NIMA for VDU. The ECDIS-N shall reject corrupted files and provide a warning of this action.

3.25.1.4 Sequence Check: The following sequence number checks shall be performed at the time of application, for both sequential and cumulative updates:

.1 file extension of the DNC® or TOD update
.2 base_data_ed
.3 library_ed

3.25.1.5 Consistency Check: The operator shall be warned of any previous DNC® or TOD updates that have not been successfully applied.

3.25.1.6 Update Applied Out of Sequence: If the VDU method used relies on sequential application of updates, the ECDIS-N shall warn the operator when an update is applied out of sequence, terminate the update operation and restore the SDNC as it was before applica-tion of the update. If the VDU method used contains all current changes from the edition date of the DNC® or TOD and does not rely on sequential application of previous updates then the warning and termination process is not required.

3.25.1.7 Summary Report: A summary report for each of NIMA's official updates shall be given after completion of receipt. The report shall contain at least:

.1 date of update (library_ed)
.2 identifiers of the DNC® or TOD libraries affected
.3 number of updates to each of the affected libraries
.4 base data that the update applies to (base_data_ed)

3.25.2 Unofficial Update

3.25.2.1 The ECDIS-N shall enable manual entry of unofficial updates for non-integrated presentation on the display. A capacity shall exist to enable the operator to:

.1 enter the update as described in IHO S-52 Appendixes 1 and 2.

.2 ensure all update text information relevant to the new condition and to the source of the update is entered by the operator and recorded by the system, for display on demand.

3.25.2.2 The ECDIS-N shall be capable of implementing manual updates to point objects and simple line and area objects such as traffic routing schemes, restricted areas and shoreline constructions, but excluding complicated lines and areas such as depth curves and coastlines.

3.25.2.3 Presentation

.1 Manual updates shall be displayed as described in IHO S-52 Appendix-2, 2.3.4.

.2 It shall be possible to remove from the display any manual update. The removed update shall be retained by the ECDIS-N for future review until the commencement of the next voyage, but will not be otherwise displayed.

3.25.3 Rejection or amendment of an official update by the operator shall be achieved by the unofficial update method. The questionable update shall be noted as an anomaly in the log.

3.25.4 Integration of Updates

.1 During the VDU process, official updates shall be clearly distinguishable on the display. Once accepted, official updates shall be integrated into the SDNC such that they are indistinguishable from DNC® or TOD data.

.2 Unofficial updates (i.e., those entered manually) shall be clearly distinguishable from DNC® or TOD data contained in the SDNC.

.3 Official updates shall be distinguished from unofficial updates.

3.25.5 Recall for Display: It shall be possible to review on demand any previous update back to the last complete replacement of the base data.

3.25.6 Log file: The ECDIS-N shall keep a record of updates through a log file. The log file shall contain, for each update applied to or rejected from the SDNC, the following information:

.1 date and time of application or rejection

.2 complete and unique identification number of the update

.3 any anomalies encountered during the application of the update (an example of "anomalies" could be error messages or load warnings)

.4 type of application: official or unofficial

3.25.7 Geographic Applicability: Updates not relating to a library within a set of DNC® or TOD available to the ECDIS-N may be discarded.

4 METHODS OF TESTING AND TEST RESULTS[9]

4.1 EUT INSTALLATION AND TECHNICAL DOCUMENTATION

4.1.1 Verify that the Equipment Under Test (EUT) is installed in compliance with the ECDIS-N manufacturer's installation manual.

4.1.2 Where equipment is divided (e.g., route planning on one display and route monitoring on the other), the entire configuration shall be tested together.

4.1.3 Verify that the ECDIS-N manufacturer provides sufficient information and documentation for the EUT to be understood and operated.

4.2 INTERFACES

4.2.1 Verify that digital signals consistent with the specifications for the appropriate Navy approved sensors are input into the EUT to emulate the position and heading of own ship. Signals may also be provided as necessary to represent velocity, depth of water beneath the keel, and keel depth [submarines only]. Perform tests using a simulator or at sea.

4.2.2 Verify that, if simulated ARPA, ATA or EPA signals are provided, they conform to Navy specifications or IEC 61162 series standards as appropriate.

4.2.3 Verify that, if simulated or real radar signals are provided to the EUT to represent radar returns, the EUT also accounts for the position of the ship in accordance with Navy specifications or IEC 60936-1 as appropriate.

4.3 ENVIRONMENTAL

Verify that all the general requirements of IEC 60945 appropriate to the "protected" category, are carried out. Verify that the ECDIS-N manufacturer declares any preconditioning required before environmental checks. For the purposes of this standard the following definitions for "Performance Check" and "Performance Test," required by IEC 60945, apply:

4.3.1 Performance Check: Reconfigure the EUT and check by non-quantitative visual checks that the system is still operative.

4.3.2 Performance Test: For the purposes of IEC 60945 the "Performance Test" for ECDIS-N EUT shall be identical to the "Performance Check".

4.4 PREPARATION

4.4.1 Power-up: Power up the EUT in accordance with the manufacturer's recommended procedures. Verify that any self-testing is completed using simulated inputs. Verify that signal generators are activated in a coherent manner to represent a stationary ship at the position selected. All the necessary selections to configure the EUT for the test environment are to be undertaken in accordance with the manufacturer's recommendations and settings.

4.4.2 Initial Ship Parameters: The following parameters (depending on the selected mode for units) shall be entered into the EUT for a simulated test:

Parameter	English	Metric
Ship length	900 ft	300 m
Ship beam	90 ft	30 m
Ship draught	21 ft	7 m

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[9] This section supplies specific methods for testing the requirements of section 3. APPENDIX 8 is a cross-reference between requirements and test methods.

Conning position:
     Aft of ship center   300 ft   100 m
     On center line

Navigation receiver antenna:
     Forward of conning position   15 ft   5 m
     Starboard of center line   30 ft   10 m

Secondary navigation receiver antenna:
     Forward of conning position   15 ft   5 m
     Port of center line   30 ft   10 m

Radar antenna:
     Forward of conning position   21 ft   7 m
     On center line

Verify that the navigation receiver antenna offset can be varied and verify that the position on the EUT changes accordingly.

4.4.3   Required Test Items: For the purpose of these tests use the following items:

    .1   GeoSym version 4 or newer
    .2   DNC® Test Data Set that includes DNC® and TOD data and updates, together with the associated instruction manual. The contents of this test data set are described in APPENDIX 7.
    .3   Color differentiation test diagrams addressed in paragraph 3.21.3 and consistent with those contained in the IHO ECDIS Presentation Library.

4.5   INITIAL DATA TESTS

4.5.1   GeoSym and ECDIS-N Chart 1

    a)   Check that the version number of GeoSym can be displayed. Observe the chart display and check that the buoy symbols are as defined in GeoSym. Check that the GeoSym version is 4 or newer.
    b)   Check that an ECDIS-N Chart 1 addressed in paragraph 3.21.2 can be displayed. Select three symbols and check that these symbols can be interrogated by cursor and that the associated text explanation contained in the ECDIS-N Chart 1 is displayed.
    c)   Load the DTDS containing a feature not valid for DNC® purpose, i.e. a feature, attribute and attribute value not recognized by GeoSym. Check that the symbol magenta "?" occurs at the indicated position on the test chart when the standard display is selected. Check that display of the symbol can be disabled.
    d)   Check that the EUT provides the capability to select for display either the "simplified" symbols for buoys and beacons, special areas, etc, or the "full chart" symbols.

4.5.2   DNC® and TOD: Check that the edition date and number of the DNC® included in the DTDS is displayed in the chart library.

4.5.2.1   Load an additional DNC® and TOD library and ensure that the chart coverage has changed and that the graphical index is updated.

4.5.2.2   Remove a DNC® and TOD library and ensure that the chart coverage has changed and that the graphical index is updated.

4.5.2.3   Load a data library whose source identification indicates that the data is not DNC®, TOD, ENC or RNC. Check that when the area of this library is displayed, the boundary of the area, or the edge of the display if the boundary is off-screen, is marked using the appropriate symbology as defined in IHO S-52 Appendix-2, 3.2.3 (13b). Verify that an indication that the chart data is inadequate for safe navigation appears.

4.5.2.4   Select a display area for part of which no data is loaded and check that the "no data" area symbolization defined in IHO S-52 Appendix-2, 3.2.3 (14) is displayed.

4.6   ACCURACY

4.6.1   Verify that:

    .1   the accuracy of ECDIS-N calculations are consistent with the SDNC;

    .2   the measurement accuracy is consistent with the display resolution.

4.6.2   Perform the measurements provided for in the DTDS and confirm that they meet the required accuracy. Check that the EUT can perform the following calculations:

    .1   true distance and azimuth between two geographical positions;

    .2   geographic position from known position and distance/azimuth.

4.6.3   Calculate and display both a rhumb line and a great circle line and verify that no visible distortion exists between these lines and the chart data. This test shall be carried out using the scale supported by the data, i.e. not over-scaled.

4.7   VISUAL REQUIREMENTS

4.7.1   Symbols

    a)   Check that the chart symbols conform to GeoSym consistent with IHO S-52 Appendix-2, 3 and Annex-A.

    b)   Check that the navigational symbols conform to APPENDIX 6 consistent with IHO S-52 Appendix-2 Annex-A, where appropriate.

    c)   Display simplified symbols. Check that the simplified symbols conform to GeoSym.

    d)   Perform zoom-in and zoom-out operations in each mode and check that the symbols do not decrease in size below that specified in GeoSym.

    e)   Check that it is possible to display own ship in true scale or as a symbol.

    f)   Using a sample of text specified in GeoSym, check that the height of upper case characters on the primary navigation console is not less than 3.5 mm.

4.7.2   Units and Legend

    a)   Check that display units can be set to either metric on English, and that metric is the power-on default. Check that units are consistent within sets as follows:

        Position   latitude and longitude in degrees, minutes and decimal minutes
        Speed   knots
        Time   hours, minutes and seconds
        Direction   degrees

        SET 1 (METRIC)
        Depth   meters
        Height   meters
        Distance   meters or Kilometers

        SET 2 (ENGLISH)
        Depth   feet or (fathoms & feet)
        Height   feet
        Distance   yards or kyards or nautical miles

    b)   Check that the following elements are in the standard legend of general information:

        .1   units for depth

        .2   units for height

        .3   scale of display

        .4   data quality indicator

        .5   sounding/vertical datum

.6 horizontal datum (WGS-84)

.7 the value of the safety depth

.8 the value of the safety contour

.9 magnetic variation

.10 date and number of last update affecting the DNC® and TOD libraries currently in use

.11 edition date and number of issue of the DNC® and TOD

.12 chart projection

4.7.3 Color Table

a) Carry out the calibration verification procedure defined in IHO S-52 Appendix-2, Annex-B, 4 applied to the bright-sun color table (or an equivalent procedure). Calibration verification shall be carried out under normal conditions as defined in IEC 60945. Verify that for each color in the bright-sun color table, the colors displayed agree with the colors in IHO S-52 Appendix-2, 4.1.1 and 4.1.5 within the tolerances given in IHO S-52 Appendix-2, 5.2.3.

b) The day-black-background, dusk, and night tables shall be tested as follows:

.1 The person conducting the test must have passed the Ishihara color blindness test taken by mariners and must adapt to night viewing for 10 min before checking the night display;

.2 Verify that the brightness and contrast controls are set to their calibrated settings;

.3 While the display is off, adjust the light level reflected from white paper positioned on the display screen to the following values:

Table 1 - Light Levels

Time Period	Light level
Day-black-background	200 cd/m^2 $\pm$ 50 %
Dusk	10 cd/m^2 $\pm$ 50 %
Night	Darkness (ECDIS-N display predominant light)

Preferably use natural daylight for the two daytime tables.

.4 Under each of the above conditions display the appropriate color differentiation test diagrams described in IHO S-52 Appendix-2, Annex A, part 3, section 4.1 for the above tables. Select each table in turn and ensure that:

- each foreground stripe is clearly distinguished from its background;

- the foreground stripes representing yellow, orange, magenta, green, blue and gray may be clearly identified.

c) If an optical filter is provided for use with the equipment, check that it can be removed from the display. From manufacturer's data verify that it has eight times attenuation (i.e. 0.9 neutral density).

d) Check that means are provided to return the display to the calibrated brightness and contrast settings.

e) Verify that the EUT manual includes a warning that use of a brightness control may inhibit visibility of information, particularly when using the night color tables.

f) Verify by observation that each of the five mandatory color tables provided in the presentation library may be selected.

4.7.4 Resolution: From information supplied by the EUT manufacturer, verify that the resolution requirement defined in paragraph 3.23.2 is met.

4.7.5 Display Characteristics: Measure the displayed chart area on the primary console of the EUT while in route monitoring mode and check that it is at least 270 mm by 270 mm.

   .1 Ensure that the displayed information is clearly visible to more than one observer, in the conditions of light normally experienced on the bridge of the ship by day and by night.

   .2 Check that in route monitoring mode any windows superimposed on the chart display area are removable and can be moved.

   .3 Check that areas on the chart-display-screen outside the chart-display-area use only clearly visible colors that do not detract from the display.

4.8 FUNCTIONAL REQUIREMENTS

   Perform the following tests in both route planning and route monitoring mode. Verify that the initial latitude/longitude position is that provided in the instruction manual for the DTDS. For all tests, confirm that there is no degradation in information content.

4.8.1 Standard Display: Follow ECDIS-N manufacturer's instructions to reinitialize EUT as if power had never been applied. Turn off the EUT and turn the EUT back on. Re-enter the initial latitude/ longitude position. Confirm that the scale displayed conforms to the largest scale available in the SDNC for the displayed area as shown on the graphical representation of the standard display provided with the DTDS. Confirm that the display mode is indicated (e.g. "standard").

4.8.2 Display Base: Select standard display. Add selectable information. Remove all selectable information. Check that the EUT display is the same as the graphical representation of the display base for the DTDS. Verify that the standard display can be restored by a single operator action. Confirm that the display mode is indicated (e.g. "base").

4.8.3 All Other Information: Select standard display. Add all other SDNC information and check that the EUT display is the same as the graphical representation of the complete DTDS. Confirm that the display mode is indicated (e.g. "standard+" or "other").

4.8.4 Display Priorities: Load the DTDS and check in detail that the drawing priority of the EUT display conforms with the drawing priority of the graphical presentation supplied with the DTDS.

4.8.5 Additional Display Functions:

   a) Verify that the navigator's notes can be displayed as described in IHO S-52 Appendix-2, 2.3.1b.
   b) Using three different symbols from GeoSym, check that these may be positioned at user defined locations on the display. Similarly, check that ten lines, twenty-five text characters, and two areas can be drawn at user-defined locations. Check that all information added by the operator is distinguishable as described in 3.23.3 and in IHO S-52 Appendix-2, 2.3.1b. Check that one of the areas can be filled. Check that all of these objects (symbols) can be added to the SDNC. Recall them from the SDNC and check that they can be deleted.
   c) If the EUT displays information, check that the presentation of the information conforms with the following:
      .1 The caution (!) or information (i) symbol is used to call up a note on the alphanumeric display by cursor picking;
      .2 Simple lines, or areas without color fill, are set up for cursor picking to give an explanatory note in the alphanumeric display. Do not use color fill;
      .3 ECDIS-N manufacturer information is distinguishable as described in IHO S-52 Appendix-2, 2.3.1c, and does not overwrite HO chart information.
   d) If non-HO data is mixed with DNC® or TOD data, it must be distinguishable as described in IHO S-52 Appendix 2, 2.3.1c. If the non-HO data is clearly separated

from the DNC®, TOD, ENC or RNC data, it may be symbolized using GeoSym or the IHO ECDIS Presentation Library, provided that:

.1 a prominent warning of "non HO data present refer to the paper chart" is displayed in this area, and

.2 the area is marked as defined in IHO S-52 Appendix-2 ,2.3.1.c and 3.2.3 (13b).

e) Verify that it is not possible to adjust the charted depth information by changes in tidal height.

4.8.6   Navigation Purpose and Scale

a) Select a library and display the information at a larger scale than that in the DNC® (overscale) by zooming in, and ensure that an indication is provided as described in IHO S-52 Appendix-2, 3.2.3 (8b).

b) Select the less detailed navigation purpose library which includes own ship's position, covered by the more detailed navigational purpose library in the DNC® and ensure than an indication is provided.

c) Select an area where different compilation scales appear on the display. Verify a boundary line between different scales is indicated as described in IHO S-52 Appendix-2, 3.2.3 (8a). Check if areas that are overscaled are identified as specified in IHO S-52 Appendix-2 Annex-A 4.1 and 4.2.

d) Verify that if the display can not be completely covered with data from the DNC® or TOD library for the detailed navigational purpose, the remaining part of the display is covered by the data from a DNC® or TOD library for the more general navigational purpose (e.g. approach or coastal).

e) Verify that a graphical index of the scale boundaries as described in IHO S-52 Appendix-2, 3.2.3 (8a) can be shown on demand.

f) Verify the ability to display intermediate scales.

g) Verify that a scale bar is provided as part of the display base at a scale of 1:80,000 or larger as described in IHO S-52 Appendix-2, 3.2.3 (9)(a).

h) Verify that a latitude bar is provided as part of the display base at all scale smaller than 1:80,000 as described in IHO S-52 Appendix-2, 3.2.3 (9)(b).

i) Set a display scale larger than 1:80,000 (e.g. 1:25,000) or the equivalent radar range scale and check that the 1 mile scale bar is displayed between 2 mm and 4 mm from the left side of the chart display area. Set a display scale smaller than 1:80 000 or the equivalent radar range scale and check that the latitude scale is displayed between 2 mm and 4 mm from the left side of the chart display area.

4.8.7   Mode and Orientation

a) If the EUT offers the capability to show other than north-up presentation:

.1 For non-north-up orientations, check that the north arrow symbol is displayed at the top left corner of the chart area, not overlapping the scale or latitude bar as described in IHO S-52 Appendix-2, 3.2.3 (10).

.2 Check that the symbol is correctly oriented.

b) Ensure that true-motion is provided. Reset the display and check that the generation of the neighboring area takes place automatically at a distance determined by the operator.

c) When in true-motion mode, check that it is possible to change manually the chart area and the position of own ship relative to the edge of the display.

d) If the EUT offers a ship-centered display mode, select a display scale such that the display shows only a portion of the chart which lies entirely within an area which is symbolized with a centered symbol (e.g. traffic lane). Check that the centered symbol is visible beneath the ship symbol.

4.8.8   Safety Contour

a) Load a DNC® library. Do not select a safety contour. Check that the equipment defaults to a 30 m safety contour depth.

b) Set the safety contour to a depth curve value not contained in the DNC® library. Verify that the EUT selects the next deeper curve in the DNC® library and displays it as the safety contour. Verify that the operator is informed.

c) Compare safety contour display with appropriate graphical representation provided with the DTDS. Verify that safety contour is emphasized. Ensure that isolated dangers within the safe waters defined by the safety contour are indicated.

4.8.9   Safety Depth: For the display of sounding text, set the initial safety depth to 10 m. Compare safety depth display with appropriate graphical representation provided with the DTDS. Verify that soundings less than the safety depth are emphasized. Repeat the test for 7 m and for 12 m. These depths are chosen because they are not depth contours. (See paragraph 3.1.7.)

4.8.10   Feature information

a) Enter the geographic coordinates of a position and display that position. Select a point, which may be a feature, symbol, or position and display its geographic coordinates.

b) Select by cursor an example of each of the following area, line and point features (see Table 2). Check that the information for the feature contained in the DNC® or TOD is displayed. Information on other features may also be displayed.

   To clearly identify each item listed below, the Feature Attribute Code Catalog (FACC) Value is listed beside the description.

   Table 2 - Area, Line and Point Features

Area:	Depth area (BE010)	Restricted area (FC036)	Sea (Water) (BA040)
Line:	Depth curve (BE010)	Ferry crossing (AQ070)	Route (maritime)(FC165)
Point:	Buoy (BC020)	Light (BC040)	Wreck (BD180)

c) Check that the text associated with chart features is displayed only when selected and that it may be removed.

4.8.11   Navigation Related Functions: Verify that at least one EBL and one VRM are available. Ensure that all the other symbols required for navigation purposes listed in APPENDIX 3 and specified in APPENDIX 6 are available. (see paragraphs 3.8.5, 3.8.5.11 and 3.9.2.)

4.8.12   Position Integration

a) Remove the simulated position input. Connect a Navy-approved continuous positioning system to the EUT and verify that the correct position is displayed.

b) With a second independent positioning method, ensure that the EUT displays any difference in reported positions.

c) Remove the positioning input to the EUT and ensure that an alarm is given.

d) Simulate a message from the positioning device that indicates an error condition, and observe that the alarm or indication is repeated by the EUT as an indication.

e) Select a different geodetic datum between the positioning system and the SDNC, and ensure that an alarm is given.

f) Adjust the position manually. Observe that the amount of the correction is displayed on the screen and that the position changes accordingly. Recheck periodically to see it remains unchanged.

g) Connect a simulated navigational information source that uses a different reference system from that used in the EUT and confirm that an indication is provided.

4.8.13 Radar and Plotting Information: Where the capability for displaying radar and plotting information is provided:

a) Observe the display without radar overlay, switch on the radar overlay and plotting information, and ensure that the SDNC information is not degraded, and is clearly distinguished.
b) Observe the display without radar, then switch on the radar overlay and plotting information and ensure these match in scale, orientation, projection and accuracy, within the ranges defined in IEC 60936-1. Check that a change of scale of the radar, if it is a separate unit, does not affect the EUT radar image in scale, orientation, projection and accuracy.
c) Ensure that the displayed position of the ship may be adjusted manually.
d) Note that the accumulated offset is clearly indicated.
e) Ensure that the radar and plotting information may be removed by single operator action.
f) Set EUT to accept and display transferred plotting targets. Set the simulator to stabilized, north-up mode and to 12-mile range. Check that the target information is being accepted and displayed correctly.
g) Vary the radar antenna offset and confirm that the position of radar overlay and plotting information on the EUT changes accordingly.

For this test, a radar target in a fixed position must be simulated.

4.8.14 Loading of corrupted data

a) Load a corrupt library from the DTDS. Verify that the EUT provides the appropriate warning.
b) Load a valid library from the DTDS. Apply a corrupted update from the DTDS using VDU. Verify that the update procedure is terminated and the record is flagged as invalid.
c) Verify that the user is informed of the corruption.

4.8.15 Automatic updates: (See paragraphs 3.1.9 and 3.25.1.3.)

4.8.15.1 Receipt - Installation and Application

a) Verify that the system can receive official updates via the removable media specified for VDU.
b) Apply a test update to the DTDS.
c) Attempt to load an improperly sequenced update; check that the update is rejected and that a warning is given to the operator. This warning and rejection is only necessary if the VDU method is sequential.

4.8.15.2 Display - Show and Verify

a) Ensure that the base_data_ed and library_ed numbers are displayed on request.
b) Ensure that the contents of the updates have been included in the SDNC. If the VDU method used provides the capability to identify the updates, this should be accomplished by displaying the SDNC contents and highlighting updates.
c) Ensure that updates not relating to a DNC® or TOD library within the SDNC are discarded.
d) Ensure that official DNC® or TOD updates can be distinguished from unofficial updates.
e) Verify that, once accepted, integrated updates are indistinguishable from DNC® or TOD data.

Apply an update to the SDNC, display the update, and then manually annotate as rejected by the operator, i.e., verify that it is not be possible for the operator to reject an officially issued update by omitting its application entirely.

4.8.15.3   Records and Logs: Tests are to be performed in all ECDIS-N operating modes, i.e. route planning and route monitoring.

   a) List on the display, and observe the contents of the record of updates, including the time of application to the SDNC.

   b) Verify that the log file contains the following information:

      .1   date and time of application/rejection (The rejection is only necessary if the VDU method is sequential. If, however, each patch is unique and not an accumulation of previous patches then the termination process is not required);

      .2   complete and unique identification of the official update described in the VDU specification or the unofficial update performed IAW IHO S-52 Appendixes 1 and 2;

      .3   any anomalies encountered during application;

      .4   type of update: unofficial/official.

   c) Verify that the summary report for the update set provides the following information:

      .1   identification of issuing authority;

      .2   update numbers of the update files;

      .3   identifiers of libraries affected;

      .4   edition number and date of the DNC$^®$ or TOD libraries involved;

      .5   number of updates in the affected libraries.

4.8.16   Unofficial Updates: Using the test data sub-set C, as described in APPENDIX 7, check that the following unofficial update procedures may be carried out and that the update is distinguishable as described in IHO S-52 Appendix-2, 2.3.4.

   a) Add new point and restricted area features from GeoSym, locating them at selected positions.

   b) Delete an existing feature.

   c) Check to see that any update text information relevant to the new condition and to the source of the update and entered by the operator is recorded by the system. Verify that this update can be re-displayed on demand.

   d) Verify that EUT is capable of sensing indications and alarms related to the SDNC data, whether from automatic or unofficial updates.

   e) Verify that unofficial updates are distinguishable as described in IHO S-52 Appendix-2, 2.3.4.

   f) Verify that any unofficial updates removed from the display are retained and can be displayed in a future review.

4.8.17   Self-tests of Major Functions

   a) Perform tests of the major functions that are supported by the EUT. Verify that the EUT provides appropriate display information and indications.

   b) Simulate the following sensor malfunctions (including for radar if provided for):

      .1   Interruption of sensor input (loss of signal);

      .2   Invalid sensor information (status);

      .3   Physical breakdown of sensor connection.

   c) Verify that the system provides suitable alarms or indication of system malfunction arising from failures.

4.9   OPERATIONAL REQUIREMENTS

4.9.1   Ergonomic Principles:

   .1   Verify that the EUT complies with the ergonomic principles noted in IEC 60945.

    .2   Verify that the acoustic alarm level is capable of the maximum level, and may be adjusted below this level.

4.9.2   Route Planning

   a) For the routes to be planned as described below, the following general guidelines apply:

     .1   Initially plan the route without specifying a safety contour. Ensure that the default value is 30 m or the next deeper depth curve.

     .2   Ensure that at least one leg enters an area where the specified safety contour is not available. Verify that the safety contour defaults to the next deeper curve and an indication is provided to the operator.

     .3   Ensure that at least one leg crosses a safety contour. Verify that an indication is provided.

     .4   Ensure that at least one leg crosses the boundary of a maritime area with entry prohibited. Verify that an indication is provided.

     .5   Ensure that at least one leg crosses the boundary of a geographical area for which special conditions exist (see APPENDIX 4). Verify that an indication is provided.

     .6   Ensure that at least one leg of the route is planned through an area of the DTDS at a different scale. Verify that the redraw occurs in 5 seconds or less.

     .7   Verify that each leg can be planned with an appropriate off track limit (e.g., 100 m).

     .8   Verify that course changes can be made, to both starboard and port, between different legs of the route and can be varied from 5° up to 175°.

     .9   Verify that the length of the legs can be varied from 0.5 nautical miles to at least 100 nautical miles with a total length at least 200 nautical miles.

     .10 Verify that the planned speed can be varied between 5 knots and 45 knots.

     .11 Ensure that the planned route crosses at least 3 libraries of the DNC® or TOD.

   b) Observe that the displayed information for route planning, route monitoring, and supplementary navigation tasks such as pilotage or chart work are available.

   c) Plan a route which uses at least 10 waypoints:

     .1   Test that the route can be planned using both rhumb lines and great circles.

     .2   Save the planned route.

   d) Retrieve the planned route and plan an alternate route as follows:

     .1   Add three waypoints;

     .2   Delete three waypoints;

     .3   Change position of two waypoints;

     .4   Change order of two waypoints;

     .5   Save the alternate route.

4.9.3   Route Monitoring

   a) For route monitoring, the following general guidelines apply:

     .1   Initialize simulator at the starting position for the planned route;

     .2   Select standard display and select the route;

     .3   Ensure that the route is planned through an area covered by the DTDS;

     .4   Carry out route monitoring using the selected routes and starting at the first waypoint;

     .5   Ensure that at least one leg crosses own ship's safety contour;

     .6   Ensure that at least one leg enters an area where the specified safety contour is not available.

.7　Ensure that at least one leg crosses an overscale area. Verify that this is indicated.

b) Operate the own ship position function, and observe that the display shows own ship's position.

c) Shortly before the vessel enters an area for which an alarm will be released (safety contour and maritime area with entry prohibited) perform the following actions:

.1　Display a sea area ahead of ship's position and outside present display (look ahead);

.2　Verify that the appropriate alarms/indications are provided;

.3　Return to own ship's position by a single operator action and verify that this takes no more than 5 s.

d) When the vessel enters the area where the specified safety contour is not available, ensure that the safety contour shown defaults to the next deeper depth curve and an indication is provided to the operator.

e) Verify that an alarm is released each time the vessel is going to cross the boundary of a maritime area with entry prohibited or safety contour, within the time specified by the operator.

f) Select a display scale smaller than the largest scale available for the area in the DNC® or TOD. Simulate crossing over the safety contour. Check that an alarm is generated by EUT using data from the largest available scale in the DNC® or TOD.

g) Using the DNC® test data set:

.1　Simulate own ship's movement from an area of large-scale data into an adjoining area of small-scale data. Ensure that each re-draw which occurs until the display is wholly within the small-scale area is completed in less than 5 seconds. (The situation where official chart data is not available is outside the scope of this test.);

.2　Select the display of an area not currently displayed, at least 10 nautical miles from own ship position and which is covered by DNC® data at a scale range different from the one in use. Check that the old display is maintained from the start of the regeneration until the start of the re-draw of the new display. Verify that an indication is given if the regeneration time is more than 5 seconds;

.3　Simulate deviation from intended track and verify that the off-track alarm is released;

.4　Verify that an alarm is released each time, within the time or distance specified, when a critical point has been reached by or is abeam of the ship;

.5　Display an alternative route and ensure that it is clearly distinguishable from the selected route. Change to the alternative route and verify that this becomes the selected route;

.6　Modify the selected route by adding a new waypoint;

.7　Select an automatic time interval, in a range 1 minute to 120 minutes. Simulate own ship's movement, and verify that the time labels are displayed on the past track. Ensure that time labels may also be entered manually.

4.9.4　Twelve Hour Log: For recording purposes (see below) verify that the data resolution is in accordance with paragraph 3.8.6.1.

a) For voyage recording, prepare a separate test route plan. Ensure that the route plan is designed as a loop. Ensure that the simulator can carry out this test automatically.

b) Continue to run the test for 12 h. During this period, attempts should be made to manually edit the log. Verify that this is not possible. At the end of the twelve-hour period, analyze the log according to the procedures in the operating manual. Verify that the results comply with the test carried out.

c) Ensure that the record for the previous 12h, including all the items defined in 3.8.6.1, is stored and available on demand. Check that chart data according to 3.8.6.1.3 is stored initially and for each change.

4.9.5   Voyage Record

a) Verify that the EUT records the track for the entire voyage, with time marks at intervals not exceeding 4 hours.

b) Ensure that the record for the previous 12 hours and the voyage track, once recorded, can be preserved.

4.9.6   Power Supply: Remove ship's power, and verify that the EUT maintains complete functionality at the primary console for a minimum of 30 minutes.

4.10   DII-COE COMPLIANCE:

Run the applicable DII COE compliance tool for the COE and the EUT. Observe that the compliance level is as specified in 3.14.11.

APPENDIX 1 - REFERENCE DOCUMENTS

The following organizations have developed technical standards and specifications, as listed below, for use in conjunction with this standard.

Chief of Naval Operations

URL = http://www.hq.navy.mil , http://www.hq.navy.mil/ECDIS-N, [SIPRNet = http://164.198.252.15/N7/N763]

Publications:

U.S. Navy Electronic Chart Display and Information System Policy; 17 Mar 98

U.S. Navy, U.S. Marine Corps Positioning, Navigation and Timing Policy; 27 June 00

OPNAV INSTRUCTION 9420.2: Implementation of the Electronic Chart Display and Information System-Navy Certification Process

Defense Information Services Agency

URL = http://www.disa.mil

Publications:

DII COE Integrated & Run-Time Specification, version 4.0   http://diicoe.disa.mil/coe/

Joint Technical Architecture   http://www-jta.itsi.disa.mil/

Department of Defense

URL = http://www.deskbook.osd.mil/

Publications:

DoD 5000.2-R (Interim); Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs; 23 Oct 2000

DoD Instruction 5000.2, Operation of the Defense Acquisition System; 23 Oct 2000

International Electrotechnical Commission (IEC)

URL = http://www.iec.ch/   Phone: +41 22 734 01 50

Publications:

IEC Publication 60872-1:Sep 1998, "Maritime Navigation and Radiocommunication Equipment and Systems - Radar Plotting Aids"

IEC Publication 60936-1: "Maritime Navigation and Radiocommunication Equipment and Systems – Radar, part 1: Shipborne – Performance Requirements, Methods of Testing and Required Test Results"

IEC Publication 60945 "General Requirements for Shipborne Radio Equipment Forming Part of the Global Maritime Distress and Safety System and Marine Navigational Equipment"

IEC Publication 61162 series "Digital Interfaces - Navigation and Radio communication Equipment On Board Ship"

IEC Publication 61174 "Electronic Chart Display and Information System (ECDIS)"

International Hydrographic Organization (IHO)

URL = http://www.iho.shom.fr/   Phone: +377 9310 8100

Publications:

INT-1: "Chart No. 1, Nautical Chart, Symbols, Abbreviations and Terms"

Special Publication No. S-52 "Provisional Specifications for a Chart Content and Display of ECDIS."

S-52 Appendix 1 "Report of the IHO (COE) Working Group on Updating the Electronic Chart."

S-52 Appendix 2 "Provisional Color and Symbol Specifications for ECDIS."

S-52 Appendix 3 "Glossary of ECDIS-related Terms."

Special Publication No. S-57 "IHO Transfer Standard for Digital Hydrographic Data"

Special Publication No. S-61 "Product Specification for Raster Navigational Charts (RNC)"

International Maritime Organization (IMO)

URL = http://www.imo.org/   Phone: +44 (0)20 7735 7611

Publications:

Resolution A.817: "Performance Standards for Electronic Chart Display and Information Systems (ECDIS)"

Maritime Safety Committee

Resolution MSC.64(67), Annex 5 "Amendment to Resolution A.817 - Performance Standards for Electronic Chart Display and Information Systems"

Resolution MSC.86(70), Annex 17 "Adoption Of New And Amended Performance Standards For Navigational Equipment"

National Imagery and Mapping Agency (NIMA)

URL = http://www.nima.mil/   Phone: 800-455-0899

Publications:

MIL-HDBK-857, Military Handbook for Geospatial Symbols for Digital Displays

MIL-PRF-89023, Digital Nautical Chart (DNC®)

MIL-PRF-89045, Geospatial Symbology for Digital Display (GeoSym)

MIL-PRF-89049/7 Littoral Warfare Data (LWD)

"   /10, Tactical Ocean Data - Level 0 (TOD0), OPNAV areas, etc

"   /11, TOD1 (bottom contour) – Classified

"   /12, TOD2 (bathymetric) – Secret

"   /14, TOD3 (CNO Special) – Secret, Compartmented

MIL-STD-2401, DoD Standard Practice, World Geodetic System (WGS 84)

MIL-STD-2402, Mapping, Charting and Geodesy Symbols for Graphic Displays

MIL-STD-2407, DoD Interface Standard, Vector Product Format (VPF)

MIL-STD-600006, Vector Product Format (VPF)

NATO Military Agency for Standardization

URL = http://www.nato.int/   Phone: +32(0)2-707-4111

STANAG 4564, Standard for Warship Electronic Chart Display and Information System (WECDIS)

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APPENDIX 2 - SDNC INFORMATION AVAILABLE FOR DISPLAY DURING ROUTE PLANNING AND ROUTE MONITORING

To clearly identify each DNC® item listed below, the Feature Attribute Code Catalog (FACC) feature code is listed beside the description. The IHO description, if different, follows in parenthesis.

1. "Display base", permanently retained on the ECDIS-N display, consisting of:

    .1   high water line - BA010 (coastline);

    .2   depth curve - BE010, crv=ssdc (own ship's safety contour), to be selected by the operator;

    .3   indication of isolated underwater dangers at depths of less than the safety contour which lie within the safe waters defined by the safety contour;

    .4   indication of isolated dangers which lie within the safe water defined by the safety contour such as bridges - AQ040, aerial cableway lines – AQ010 (overhead wire), etc., including buoys - BC020 and beacons - BC010, whether or not these are being used as aids to navigation;

    .5   route, maritime - FC165 (traffic routing systems);

    .6   scale, range, orientation, and display mode;

    .7   units of depth and height.

2. "Standard display", to be displayed when the chart is first displayed by ECDIS-N, consisting of:

    .1   display base

    .2   foreshore - BA020 (drying line)

    .3   indication of fixed and floating aids to navigation

    .4   boundaries of fairways, channels, etc. - FC021, mac=55

    .5   visual and radar conspicuous features

    .6   prohibited and restricted areas - FC036

    .7   chart scale boundaries

    .8   indication of cautionary notes

3. All other information, displayed individually on demand, for example:

    .1   soundings - BE020 spot soundings

    .2   submarine cables - AT005 and pipelines - AQ113, loc<>25 and pro 116

    .3   ferry crossings - AQ070 (ferry routes)

    .4   details of all isolated dangers

    .5   details of aids to navigation

    .6   contents of cautionary notes

    .7   DNC® and TOD edition date

    .8   geodetic datum (WGS-84)

    .9   magnetic variation

    .10 graticule

    .11 place names

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APPENDIX 3 - NAVIGATIONAL ELEMENTS AND PARAMETERS

1. Own ship
    .1   Past track with time marks for primary track
    .2   Past track with time marks for secondary track
2. Vector for course and speed made good
3. Variable range marker and/or electronic bearing line
4. Cursor
5. Event
    .1   Dead reckoning position and time (DR)
    .2   Estimated position and time (EP)
6. Fix and time
7. Position line and time
8. Transferred position line and time
    .1   Predicted tidal stream or current vector with effective time and strength (in box)
    .2   Actual tidal stream or current vector with effective time and strength (in box)
9. Danger highlight
10. Clearing line
11. Planned course and speed to make good. Speed is shown in box
12. Waypoint
13. Distance to run
14. Planned position with date and time
15. Visual limits of lights arc to show rising/dipping
16. Position and time of "wheel-over"
17. Turn bearing and turn range
18. Swing circle and drag circle around own ship when anchored
19. Dead reckoning plot

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APPENDIX 4 - AREAS FOR WHICH SPECIAL CONDITIONS EXIST

The following are the areas that the ECDIS-N shall detect and for which it shall provide an alarm or indication under 3.8.4.5 and 3.8.5.4. To clearly identify each item listed below the DNC® or TOD description, Feature Attribute Code Catalog (FACC) feature code and if appropriate, the attribute expression are listed beside the description. The IHO description, if different, follows in parenthesis.

1. Traffic separation scheme, separation zone - FC041, tsp=3 (Traffic separation zone)
2. Maritime Area, Roundabout Zone (TSS), FC031, mac=40 (Traffic routing scheme crossing or roundabout)
3. Maritime Limit Boundary, precautionary - FC021, mac=42 (Traffic routing scheme precautionary area)
4. Route maritime, 2-way - FC165, rtt=11(Two-way traffic route)
5. Route maritime, deep water - FC165, rtt=4 (Deepwater route)
6. Safety fairway - FC170 (Recommended traffic lane)
7. Maritime area, inshore traffic zone (TSS) - FC031, mac=41 (Inshore traffic zone)
8. Fairway - FC021, mac=55,
9. Restricted area - (FC036)
10. Maritime area, unknown - FC031, mac=0 or 9 (Caution area)
11. Maritime limit boundary, Oil Field or Gas Field - FC021, mac=32 or 33 (Offshore production area)
12. Restricted area, areas to be avoided - FC036, mac=43 (Areas to be avoided)
13. Maritime limit boundary, submarine exercise, mine laying, firing range - FC021, mac=27, 28, 29, 115, 116, 140, 146, 147, 150, 151, 152, 153, 157, 159 (Military practice area)
14. Seaplane landing area - GB070
15. Maritime area, submarine traffic lane submerged "TOD only" - FC031, mac=108 (Submarine transit lane)
16. Ice shelf - BJ065 (Ice area)
17. Maritime limit boundary, fairway - FC021, mac=55 (Channel)
18. Fishing ground (not listed in DNC®)
19. Restricted area, fishing prohibited - FC036, mac=22 (Fishing prohibited)
20. Restricted area, pipelines - FC036, mac=21 (Pipeline area)
21. Restricted area, cables - FC036, mac=20 (Cable area)
22. Anchorage, not an anchoring berth - BB010, mac<>12 (Anchorage area)
23. Restricted area, anchoring prohibited - FC036, mac=15 (Anchorage prohibited)
24. Maritime limit boundary, dumping - FC021, mac=30 (Dumping ground)
25. Maritime limit boundary, spoil - FC021, mac=25 (Spoil ground)
26. Maritime area, dredged area - FC031, mac=2 (Dredged area)
27. Maritime limit boundary, cargo Xshipment - FC021, mac=49 (Cargo transhipment area)
28. Maritime limit boundary, incineration - FC021, mac=31 (Incineration area)
29. Maritime area, entry prohibited - FC036, mac=5 (Specially protected areas)

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APPENDIX 5 - ALARMS AND INDICATIONS

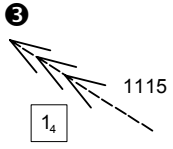| Section	Requirements	Information
3.3.1.1	Indication	Information overscale
3.3.1.2	Indication	Larger scale DNC® and TOD available (if applicable)
3.4.2	Indication	Different reference system
3.8.3	Alarm or Indication	Largest scale for alarm
3.8.4.4	Indication	Route planning across safety contour
3.8.4.5	Indication	Route planning across specified area
3.8.4.6	Alarm	Exceeding off-track limits
3.8.5.3	Alarm	Crossing safety contour
3.8.5.4	Alarm or Indication	Area with special conditions
3.8.5.5	Alarm	Deviation from route
3.8.5.7	Alarm and Indication	Positioning system failure
3.8.5.8	Alarm	Approach to critical point
3.8.5.9	Alarm	Different geodetic datum
3.11.1	Indication	System test failure
3.11.2	Alarm or Indication	Malfunction of ECDIS-N

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APPENDIX 6 - NAVIGATIONAL SYMBOLS

1 Introduction

1.1 This annex provides a description of the navigational symbols to be used on ECDIS-N, as listed in APPENDIX 3.

1.2 This annex has been developed to ensure that the navigational Symbols used on ECDIS-N are consistent with those used for navigation on ECDIS (IEC 61174) and those used for target tracking and collision avoidance on electronic plotting devices e.g. ARPA, ATA and EPA (IEC 60872 series).
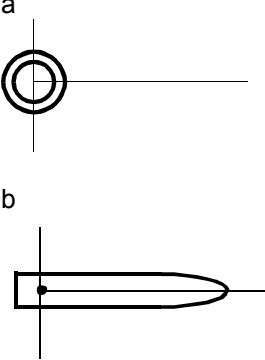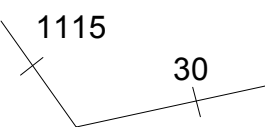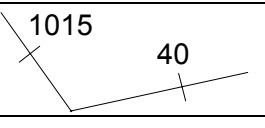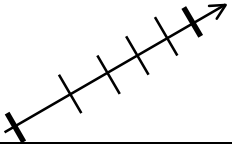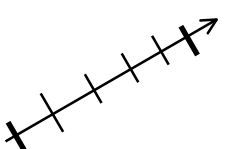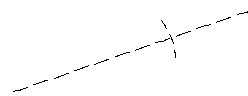
2 Symbols

2.1 If navigational symbols are used on other equipment e.g. ARPA, these symbols, the color palette and symbol sizes used in such cases may be left to the discretion of the manufacturer.

2.2 Additional symbols may be used for other navigational purposes provided that they do not conflict with the ECDIS-N navigational and chart symbols including electronic plotting symbols and that they use appropriate color palettes.

2.3 Alphanumeric labels are to be of a size such that they are clearly legible.

2.4 Colors for the symbols are defined in the IHO S-52 Appendix 2 and Annexes.

2.5 Symbol definition format:

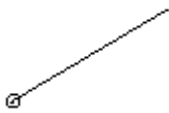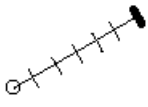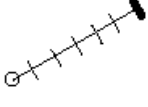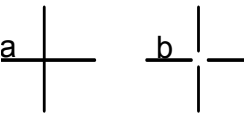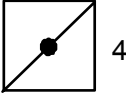| Tidal Stream ❶				
❷ 8.1	❸ 1115 1₄	❹ Predicted tidal stream or current vector with effective time and strength (in [3] box)	❺ Predicted from tidal database	❻ ninfo, *orange*

    ❶   Section
    ❷   Subsection number
    ❸   Symbol to be used on ECDIS-N
    ❹   Description
    ❺   Notes
    ❻   Color_token, *color_name* (or *day/night* color names where they are different)
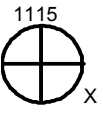
2.6 Route monitoring and route planning symbols

	Route monitoring – position lines			
1	a / b (Own ship symbol illustrations)	Own ship	The use of symbol 1- a/b on radar systems is optional. Symbol 'b' must be scaled to indicate length and beam of the vessel and may be representative of own ship's outline. In either case the largest dimension of the symbol shall not be less than 6 mm. Heading and beam lines are optional. When displayed, heading line extends to chart window edge and beam line extends 10mm (optionally extendable).	ships, *black /* *white*
1.1	1115 30	Past track with time marks for Primary track	Time mark intervals may be set by the operator. Time to be HHMM or MM.	pstrk, *black /* *white*
1.2	1015 40	Past track with time marks for Secondary track	The operator may set time mark intervals. Time to be HHMM or MM.	sytrk, *grey*
2.1	(vector illustration)	Own ship's vector for course and speed made good (i.e. over ground)	Marks at 1-minute intervals. Filled mark at 6-minute intervals. Length represents user-selected period applied to ALL vectors.	ships, *black /* *white*
2.2	(vector illustration)	Own ship's vector for course and speed through water	Marks at 1-minute intervals. Filled mark at 6-minute intervals. Length represents user-selected period applied to ALL vectors.	ships, *black /* *white*
3	(EBL illustration)	Variable range marker and/or electronic bearing line	The VRM and EBL may be ship centered or freely movable. A small filled circle indicates the EBL origin when offset. An EBL is to be an interrupted line with long dashes. The first VRM is to be a long dashed ring. The second VRM is to be a long dashed ring distinguished by a different line style of dashes.	ninfo, *orange*
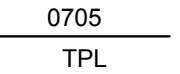
		Target tracking – AIS reported targets		
2.3		"Active" AIS target	Center is pivot point. Orientated with heading. Heading line is 25 mm long.	arpat, *blue-green*
2.4		"Sleeping" AIS target To avoid confusion with AIS target with no associated vector.	Center is pivot point. Orientated with heading. "Sleeping" AIS has no vector.	arpat, *blue-green*
2.5		Vector for course and speed made good (i.e. over ground).	Marks at 1-min intervals. Filled mark at 6-min intervals. Length represents user-selected period applied to ALL vectors.	arpat, *blue-green*
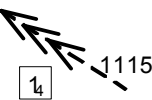
		Electronic plotting video symbols - IEC 60872		
2.6		Plotted target – Course and speed vector IEC 60872 video symbol 4A		arpat, *blue-green*
2.7		Vector for course and speed made good (i.e. over ground). IEC 60872 video symbol 4B	Marks at 1 min intervals. Thick mark at 6 min intervals. Length represents user selected period applied to ALL vectors. To indicate that all vectors are ground-stabilized (i.e. showing course and speed over ground) a double arrow may be added, to the end of the own ship true vector.	ships, *black / white*
2.8		Vector for course and speed through water. IEC 60872 video symbol 4B	Marks at 1 min intervals. Thick mark at 6 min intervals. Length represents user selected period applied to ALL vectors. To indicate that all vectors are sea-stabilized (i.e. showing course and speed through water) a single arrow may be added, to the end of the own ship true vector.	ships, *black / white*
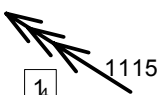
		Route monitoring – general [All own ship references relate to the conning position]		
4	a ──┼── b ──┤	Cursor	The cursor crossover point may be left blank as shown in 'b'. In either case the largest dimension of the symbol shall not be less than 10 mm.	cursr, *orange*
5	⬜ (diagonal line with dot) 4	Event	The symbol may be numbered and have additional text such as time / "MOB" associated with it.	ninfo, *orange*

		Route monitoring – calculated positions (indicated by thickened circle)		
5.1	1115 ⊕ DR	Dead reckoning position and time (DR)		ninfo, *orange*
5.2	1115 ⊕ EP	Estimated position and time (EP)		ninfo, *orange*

		Route monitoring – position fixes		

V - Visual   GI - Glonass   A - Astronomical   L - Loran / Tchaika
R - Radar   M - MFDF   D - Decca   O - Omega
G - GPS   T - Transit / Tsikada
[A differential system is denoted by a prefix ´d´, e.g. dG, dO, etc.]

6	1115 ⊕ X	Fix and time	X indicates method of fix	ninfo, *orange*

		Route monitoring – position lines		
7	___0705___	Position line and time		ninfo, *orange*
8	___0705___ TPL	Transferred position line and time		ninfo, *orange*
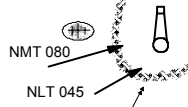
		Route planning - tidal stream		
8.1	⇖ 1115 1̶	Predicted tidal stream or current vector with effective time and strength (in box)	Predicted from tidal database	ninfo, *orange*

		strength (in box)		
8.2		Actual tidal stream or current vector with effective time and strength (in box)	Measured from available sensor information. Strength to be displayed in knots	ninfo, *orange*
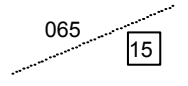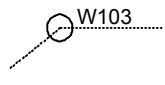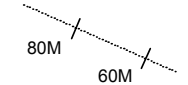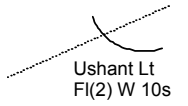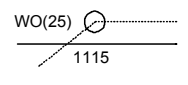
Route planning - danger highlight		

9		Danger highlight	Transparent red danger areas drawn by the operator. May be flashing. Examples shown are wrecks. All underlying chart data shall be clearly visible.	dnghl, *red*

Route planning – clearing lines		

10	NMT 080 NLT 045	Clearing line NMT = Not more than NLT = Not less than	Example is shown for clearing a wreck and north mark buoy	ninfo, *orange*

Route Monitoring – Calculated positions (indicated by thickened circle)		

11	065 15	Planned course and speed to make good. Speed is shown in box.		plrte/aplrt, *red / orange*
12	W103	Waypoint (Used in conjunction with symbols 14 and 19)	Waypoints may be labeled. Label shall be unique. First character shall be a letter but not ´O´, ´I´ or ´Z´	plrte/aplrt, *red / orange*
13	80M 60M	Distance to run	May be replaced by more direct means	plrte/aplrt, *red / orange*
14	20/1115	Planned position with date and time.	May be replaced by more direct means	plrte/aplrt, *red / orange*
15	Ushant Lt Fl(2) W 10s	Visual limits of lights, arc to shore rising/dipping range	Inscriptions are optional Note: not shown on alternate route	ninfo, *orange*
16	WO(25) 1115	Estimated position and time (EP). Position and time of "wheel-over"	Minimum symbol to indicate "wheel-over" line (annotated ´WO´), other data can be optionally provided. Note: not shown on alternate route	ninfo, *orange*

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APPENDIX 7 - DNC® TEST DATA SET (DTDS)

1 General requirements

1.1 This data set is necessary to accomplish all ECDIS-N testing requirements that are specified in this standard. The data shall be encoded according to the DNC® product specification. The data shall be provided, in an unencrypted form, on CD-ROM.

1.2 The test data set shall include:

- data sub-set A for testing the DNC®;
- data sub-set B for testing official updating.

1.3 In addition to these data sets the following shall be provided:

- an instruction manual;
- a set of graphical representations;
- a read-me file which shall include this specification together with an index to the data contents.

2 Data sub-set A: DNC®

2.1 Complex area: This data set shall cover a complex area representing a complicated navigational scenario. The contents shall include:

.1 At least four, large scale libraries (> 1:80,000) providing continuous coverage;

.2 An area containing no data;

.3 Examples of features from each of the priority layers defined in 5.3(a) of IHO S-52 and 2.3.2 of Appendix 2 of IHO S-52;

.4 An example of a feature, attribute and attribute value not valid for DNC® purposes;

.5 At least two scale-area meta objects;

.6 An example of corrupted data;

.7 An example of a feature which is depicted as an area with an associated area-centered symbol;

.8 An example of all of the features specified in 4.8.10 Table-2;

.9 An example of "unofficial" data, (i.e. data whose source identification indicates that the data is not produced by NIMA but is in VPF).

2.2 Small scale data: The data set shall include equivalent data for the next smaller scale navigational purpose for the area specified in APPENDIX 7 paragraph 2.1. The data shall be at a scale of < 1:80,000 and shall include an area sufficient to cover a route of 25 nautical miles. It shall also include an area situated at least 10 nautical miles from the center of the specified area.

2.3 Data content: The content of the data set shall support the use of display base, standard display and all other information as specified in APPENDIX 3.

2.4 Alarms and indications: The data set shall include:

.1 the 0 m, 10 m, 20 m, 30 m and 40 m depth curves in one library and the 0 m, 10 m, 25 m, 30 m and 40 m depth curves in an adjacent library;

.2 a range of soundings, including a 5 m and 15 m sounding;

.3 examples of all features that trigger alarms or indications as listed in APPENDIX 5.

2.5   Alarms and indications: large scale data: Where the large scale data (APPENDIX 7-2.1) and the smaller scale data (APPENDIX 7-2.2) overlap, the large scale data set shall be more geometrically complex than the smaller scale data for features which trigger alarms and indications.

2.6   Mathematical calculations: A separate text document shall be provided containing a selection of positions, distances, bearings, etc., relating to the data set and which support examples of all the navigational calculations listed in 7.1 of S-52.

2.7   Graphical representations: Graphical representations of the data set shall be provided to the requisite accuracy and resolution for:

   .1   Base display;

   .2   Standard display;

   .3   All other information; and

   .4   Small scale data for area (APPENDIX 7-2.2).

3   Data sub-set B: Official updating

3.1   Update data - Contents: The data set shall include:

   .1   Multiple individual updates, certain of which shall affect topology;

   .2   An update with an invalid producing agency identifier;

   .3   An update referring to a superseded edition of a library;

   .4   An update which comes into effect at a future date;

   .5   Data which falls outside the area of data sub-set A;

   .6   An example of corrupted data;

   .7   A separate text document containing the required contents of a VDU Summary Report and a system application report comparable to IHO S-52 Appendix-1 3.4.2(f).

3.2   Update data - Sequence: The data set shall include a sequence of updates, e.g. 1, 2, 3, 4 and 5, where 3 and 4 are logically linked but two versions of 3 are provided, one which makes 4 invalid, the other being compatible with 4.

APPENDIX 8 - REQUIREMENTS / TEST PARAGRAPH CROSS MATRIX

Req.	Test Paragraph	Comment	Req.	Test Paragraph	Comment
3.1.1	4.5.1, 4.8.2 – 4.8.5		3.8.4.2	4.9.2.d	
3.1.2	4.8.1 – 4.8.3	Appendix 2	3.8.4.3	4.9.2.d	
3.1.3	4.8.2		3.8.4.4	4.9.2.a.3	
3.1.4	4.8.1		3.8.4.5	4.9.2.a.4 & .5	
3.1.5	4.8.2		3.8.4.6	4.9.2.a	
3.1.6	4.8.8.c		3.8.4.7	None	Navigation Object Highlight
3.1.7	4.8.9				
3.1.8	4.5, 4.8		3.8.4.8	None	Distance from Land Overlays
3.1.9	4.8.15.2				
3.1.10	4.8.5 b-d, 4.8.15, 4.8.16	Appendix 3	3.8.5.1	4.9.3.b	
			3.8.5.2	4.9.3.c	
3.2.1	4.5.2, 4.8.6.e		3.8.5.3	4.9.3.e	
3.2.1.1	None		3.8.5.4	4.9.3.e	
3.2.1.2	None		3.8.5.5	4.9.3.g.3	
3.2.2	4.5		3.8.5.6	4.8.12	
3.2.3	None		3.8.5.7	4.8.12.c & .d	
3.2.4	None		3.8.5.8	4.9.3.g.4	
3.2.5	4.8.15		3.8.5.9	4.8.12.e	
3.2.6	4.8.16		3.8.5.10	4.9.3.g.5	
3.2.7	4.8.15.3		3.8.5.11.1	4.9.3.g.7	
3.2.8	4.8.15.2.b		3.8.5.11.2	4.8.11	Appendix 3
3.3.1.1	4.8.6.a		3.8.5.12	4.8.10.a	
3.3.1.2	4.8.6.b		3.8.5.13	4.8.12.f, 4.9.4.c	
3.4.1	4.8.13.a		3.8.6.1	4.9.4	
3.4.2	4.8.12.g		3.8.6.2	4.9.4.c	
3.4.3.1	4.2.2	1st sentence	3.8.6.3	4.9.5.a	
3.4.3.1	None	2nd sentence	3.8.6.4	4.9.4.b	
3.4.3.2	4.8.13.b		3.8.6.5	4.9.5.b	
3.4.3.3	4.8.13.g		3.9.1	4.6.1.1	
3.4.3.4	4.8.13.c & .d		3.9.2	4.6.1.2, 4.6.2	
3.4.3.5	4.8.13.e		3.10.1	4.2.1	
3.4.4	None	All (LOP)	3.10.2	4.2.1	
3.4.5.1	None	DR Plot	3.11.1	4.8.17.a & .b	
3.4.5.2	None	Set & Drift	3.11.2	4.8.17.c	
3.5.1	4.8.7.a		3.12	None	B/U Arrangements
3.5.2	4.8.7.b		3.13.1	None	
3.5.3	4.8.7.c		3.13.2	4.9.6	
3.5.4	4.8.7.c		3.13.3	None	B/U Power Supply
3.6.1	4.7.1.a		3.14	None	Operational Issues
3.6.2	4.7.1.b	Appendix 3, Appendix 6	3.15	None	Required Support
			3.16.1	None	Direct Read DNC
3.6.3	4.7.1.d	1st sentence	3.16.2	4.6.1.1	
3.6.3	4.5.1.a	2nd sentence	3.17	4.8.4	
3.6.4	4.7.1.e		3.18.1.1	4.8.6	
3.7.1.1	4.9.2		3.18.1.2	4.8.6.d	1st sentence
3.7.1.2	4.9.3		3.18.1.2	None	2nd sentence
3.7.2	4.7.5		3.18.1.3	4.5.2, 4.8.6.e	
3.7.3	4.7.3, 4.7.4		3.18.1.4	4.8.6.c	
3.7.4	4.7.5.1		3.18.1.5	4.8.6.f	
3.8.1	4.9.2, 4.9.3	1st sentence	3.18.1.6	4.8.6.g & .j	
3.8.1	None	2nd sentence	3.18.1.7	4.8.6.h & .j	
3.8.2	4.9.1.1		3.18.2	4.7.1.f	
3.8.3	4.9.3	Appendix 5	3.18.3.1	4.7.2	
3.8.4.1	4.9.2.c		3.18.3.3	4.7.2	

Req.	Test Paragraph	Comment	Req.	Test Paragraph	Comment
3.18.3.4	4.7.2.b		3.25.1.4.2	4.8.15.3.2	
3.19.1	4.8.10.		3.25.1.4.3	4.8.15.3.b.3	
3.19.1.1	4.8.10.b		3.25.1.4.4	4.8.15.3.b.4	
3.19.1.2	4.8.10.b		3.25.1.5	4.8.15.1.b & .c	
3.19.1.3	4.8.10.c		3.25.2.1	4.8.16	
3.19.2	4.8.7.d		3.25.2.2	4.8.16.d	
3.19.3	4.8.8		3.25.2.3.1	4.8.16.e	
3.19.3.1	4.8.8.a & .b		3.25.2.3.2	4.8.16.f	
3.19.3.2	4.8.8.b, 4.9.2, 4.9.3		3.25.3	4.8.15.1	VDU
3.19.3.3	4.8.8.b, 4.9.2, 4.9.3		3.25.4	4.8.14	
3.19.4.1.1	4.8.10		3.25.5	4.8.15.3	
3.19.4.1.2	4.6.2.1		3.25.6	4.8.15.1	
3.19.4.1.3	4.6.2.2		3.25.7	4.8.15.2	
3.19.4.1.4	4.6.3		3.25.8	4.8.15.3.e	
3.19.4.1.5	4.6.3		3.25.9	4.8.15.2	
3.19.4.2	4.6.3		3.25.10	None	Mods of Updates
3.20.1.1	4.8.5.c.1				
3.20.1.2	4.8.5.c.2				
3.20.1.3	4.8.5.b				
3.20.1.4	4.8.5.a				
3.20.2.1	4.8.5.d				
3.20.2.2	4.5.2.3				
3.20.2.3	4.5.3.4				
3.20.2.4	4.8.5.d.1				
3.20.2.5	4.5.1.c				
3.20.3	4.8.5.e				
3.21.1	4.5.1.a				
3.21.2	4.5.1.b, 4.5.1.d				
3.21.3	4.7.3				
3.22.1	None				
3.22.1.1	4.8.2				
3.22.1.2	4.8.2				
3.22.1.3	4.8.5.a				
3.23.1	None				
3.23.1.1	4.9.3.g.1				
3.23.1.2	4.9.3.g.2				
3.23.2.1	4.7.4				
3.23.2.2	4.7.1.d				
3.23.2.3	4.7.1				
3.23.3	4.7.3				
3.23.4.1	4.7.3				
3.23.4.2	4.7.3				
3.23.4.3	4.7.3				
3.23.4.4	4.7.3				
3.24.1	4.7.1.c				
3.24.2	4.8.7.a				
3.24.3	4.7.5.2				
3.24.3.1	4.7.5.2				
3.24.4	4.7.5.3				
3.25.1.1	None				
3.25.1.2.1	4.8.15.2.e				
3.25.1.2.2	4.8.15.2.d				
3.25.1.2.3	4.8.15.2.d				
3.25.1.3	4.8.15.2.a, 4.8.16				
3.25.1.4	4.8.15.2.a				
3.25.1.4.1	4.8.15.3.d & b.1				